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RECONSTRUCTION AT SAVOY PLACE?

ONCE AGAIN THE ANNUAL GENERAL Meeting is at hand. Although only a small fraction of the membership is able to attend this meeting, many members probably dip into the Council's Annual Report, which is presented at the meeting and later published in the *Journal*. Copies of the Report for 1956–57 are now available, and in it may be found a paragraph that is concerned literally with the place The Institution occupies to-day. In this the Council announce that they now think it advisable to carry out a 'limited modification' of The Institution building.

With the ever-growing membership and range of activity of The Institution, the Council have realized for some years that the headquarters building, as now constructed, would not satisfy The Institution's needs much longer. Over the last decade there has been increasing pressure on the Committee Rooms and on space in the Lecture Theatre: overflow meetings have become all too common. Moreover, the building has no big public room, such as is often required for receptions and exhibitions, and there is no real set of interconnecting rooms for people to circulate in at large gatherings.

Members who study The Institution's annual accounts will know that there exists a Rebuilding Reserve Fund, and this now stands at about £220 000. Before it became clear that no British Government would quickly halt the stride of post-war inflation, the Council had some hope that a completely new building on a fresh site would be feasible. Now, faced with the 'exceptionally high cost of such a project under existing economic conditions', the Council propose that improvements to the present building would be the best course with the funds available. Alterations would not of course begin until they had been approved by a Special General Meeting of Corporate Members and Associates.

The building stands on land in the Manor of the Savoy, which is part of the Duchy of Lancaster, and work on its construction began in 1886. The original architect, Salter, achieved in the exterior, of warm red brick and Portland stone, a most competent example of late Victorian architecture, in a style influenced by the renaissance revival of the time. Not everyone likes the pediments on the wings, but few would disagree that the building as a whole adds a touch of distinction to the rather unsatisfactory set of structures that now flank Victoria Embankment Gardens between Waterloo and Charing Cross Bridges. The present consulting architects to The Institution, the well-known firm of Adams, Holden and Pearson, are the direct successors of Salter, who was for a time in partnership with Dr. Percy Adams.

As is well known, the building was designed as an Examination Hall for the Royal Colleges of Physicians and Surgeons. After a state drive, with six carriages attending her, Queen Victoria herself laid the foundation stone, amid much royal splendour and in the presence of the Prince of Wales. A short ceremony included singing by the Choir of the Savoy Chapel and ended with benediction from the Archbishop of Canterbury. Probably few members know that immured in the building's walls are two glass jars containing coins of 1886, and current copies of *The Times*, *The Morning Post*, and *The Lancet*. Thus at some future date—but let us hope it will be many decades, if not centuries, ahead—The Institution may find itself the owner of some interesting and not entirely valueless Victoriana.

After The Institution had purchased the leasehold of the Examination Hall in 1909 and transferred its offices from Victoria Street in 1910, extensive interior alterations were carried out under the supervision of Dr. Adams, to fit the building to its new purposes. In particular the original lecture theatre and entrance hall were made larger and many of the smaller examination rooms and laboratories were divided to make offices. The largest examination room, with its fine outlook over the Thames, became the present library. Paradoxically, the offices in the building have always been too numerous for The Institution's needs. Since 1910 there have been tenants in some of them—tenants whom the Council have especially welcomed because they have usually been other electrical organizations. But in recent years requirements for more offices have made inroads on the space available for letting, and the Council have regretfully been unable to renew certain leases.

Thus after nearly 50 years' life in the first house of its own, The Institution is faced with the problem of putting that house in better order to suit its growing membership and responsibilities in the Britain of to-day. The best solution is not yet clear, but much study has been given to finding it, and it is possible that the President will be able to make a preliminary statement at the meeting on the 23rd May.

Engineering Education in the Soviet Union

The Report of the team of engineers who visited Russia in 1956 to study Russian engineering education was presented at a Joint Meeting of the three major engineering Institutions*

THE number of engineering diplomas awarded in the U.S.S.R. in 1955 may be taken as 65 000—including architecture and metallurgy, in which the numbers of students are comparatively small. In the United Kingdom for the year 1954–55 the number of awards of a standard which satisfies the examination requirements for Associate Membership of the major engineering institutions was about 5000. Taking into account that the population of the U.S.S.R. is about four times that of the United Kingdom, we see that Russia is training engineers at about three times the rate in this country. But population is not necessarily a good basis for comparing the numbers of engineers; although engineering production and the number of engineers required for production may be related to the size of population, the development of new ideas and of new techniques is not so related. Even if the numbers of our own engineers were greater than the Russian figures on the population basis, we could not be complacent; however they are only approximately one-third.

Much has been written and spoken on these lines in the last few years, but insufficient was known of the true comparison between the Russian and the British systems in relation to the quality as well as the quantity of engineering education. The Report of the team of engineers who visited Russia in the autumn of 1956 deals with the whole field of Russian engineering education, and the comparisons made with the British system reinforce the views of those who regard British progress in technological education as inadequate to meet the urgent needs of the coming years.

In any country which is suffering from a shortage of engineers there are two main problems: finding enough suitable young people for training as engineers and ensuring they are properly trained. In Russia the first of these problems, to supply suitable students, presents less difficulty than it does here, because engineering has been made one of the most attractive careers in the country. Not only is it as well paid as any other, with one exception, but it is highly esteemed as contributing greatly to the welfare of the country.

The second problem, that of ensuring good engineering training, has two aspects: the staff and the material facilities of accommodation and equipment. The one profession which is better paid than engineering is higher education. The professor is better paid than his counterpart in industry, and so those who find that their interests lie in teaching and research need not hesitate on financial grounds. Moreover, the junior grades in higher education are also paid at higher rates than they would receive in industry. Consequently, there is no difficulty in recruiting engineering teachers. Buildings and equipment for engineering education in Russia are not yet adequate to the needs but this difficulty is overcome by the institutes working two shifts, where necessary, and for this purpose additional teaching staff are employed. The urgent work of training engineers is not allowed to wait for the provision of more accommodation or equipment in the institutes.

The general educational system in the Soviet Union is a ten-year school course, beginning at 7+ years of age, before which age the child has no formal education. At 17+ students are selected for entry to the universities and technical institutes—universities for arts, languages, mathematics and pure science, and the technical institutes for applied science. The normal engineering course is five years, followed by six months spent on the preparation of a thesis on a particular project. The first two years are widely based and give a good general foundation; the third year covers a fairly wide range of subjects, and the fourth and fifth years are devoted to a detailed study in a specialized branch. The project is a practical problem of engineering design, manufacture or construction within that specialty. During the 5½-year course two periods of three months are spent in industry under the close supervision of the college authorities, and the practical experience gained there is not on the shop floor as in this country, but as an assistant to a qualified engineer.

At the end of the 5½-year course successful students are able to take their part in industry as engineers on the particular work in which they have specialized. There is close integration between industry, research and higher education with a measure of interchange of staff between industry and the institutes. Professors and teaching staff are allowed to undertake industrial consulting work and thereby increase their remuneration by as much as 50%. A further co-ordinating link between policy and practice is secured by some of the university and institute professors holding high office in the Ministry of Higher Education.

Industrial experience is taken into account in accepting

* As announced last month, copies of the Report and discussion are available from the Secretary of The Institution, price 3s. each.

students for the full-time courses, and those who on leaving school fail to secure acceptance after the entrance examination at the first application may apply later when they have acquired industrial experience. Many of the institutes have evening courses and correspondence courses leading to the award of the same engineering diploma as the full-time courses, but with a narrower specialization of subjects.

It is impossible in a short space to summarize the team's views on details of the various courses, but a broad conclusion was that, in comparison with the British engineering first-degree man, the Russian engineering-diploma man stands the higher on average. However, the post-graduate industrial apprenticeship in Great Britain has no parallel in the Soviet Union, for the Russian graduate usually starts his practice as an engineer without further training. It may well be more realistic, therefore, to compare a Russian diploma man with the British graduate who has completed his post-graduate training, and on this basis the British graduate takes first place.

The Report was discussed at a Joint Meeting of the Institutions of Civil, Mechanical and Electrical Engineers on the 25th February at the Institution of Civil Engineers, with Sir Gordon Radley in the chair. The Report was introduced by Professor E. Giffin, who was the leader of the team, and the discussion was opened by Dr. Willis Jackson, the subsequent speakers being Sir Gilbert Flemming, Sir Paul Sinker, Professors J. Lenkowski and A. Smolinski (from Poland), Mr. C. T. Melling, Lord Waverley, Mr. G. Lacey, Mr. H. A. Warner, Mr. J. F. Coales and Mr. R. T. B. Wynn.

The team had seen much in 11 days, for they had visited technical institutes, technicums for the training of technicians, and manufacturing works in both Moscow and Leningrad. From their observations they found the students to be of a standard which justified the training and they found the training to be good. On completion of the course, the graduates seemed able to take their proper place in industry as engineers. This conclusion spoke well for the course and the teachers, and on detailed consideration of both curricula and staff the team was satisfied that the Russians had ensured a high quality of graduates.

Speakers who had visited Russia with other teams agreed that the attitude towards engineering and engineering education had been attuned to the needs of the country and that much remains to be done here before our people have a proper regard for technology.

Under the system which obtains in the Soviet Union, there is little difficulty in securing a high degree of co-ordination between (i) the development of higher education under the prevailing economic conditions, (ii) industry and (iii) the general educational system. The Russian experience does not give us any answer to our own problem, but on the other hand, it does give us cause to think. We must regard the new developments in technical education, such as the new Dip.Tech.(Eng.) 'sandwich' courses, as only a partial solution to our national problem of engineering education. These developments are good in themselves but still insufficient. They require to be properly backed by a public regard for higher engineering education to meet the developing needs of industry, and by a greater realization of the vital importance of continued research in the pure and applied sciences.

We require a much larger number of engineering students, but so far we have not given real encouragement to girls and women to enter the engineering profession. In Russia about 50% of engineering students are women but one professor had said that while women as students were just as successful as men, they were, on the average, not as good subsequently as engineers. On the other hand, the team on engineering education and other teams had met some women holding high appointments in industry, albeit fewer than those held by men.

Speakers referred to the work of the technicums and the well-qualified technicians met by various teams from this country, and to the practical training of craftsmen in the Soviet Union. Other subjects discussed included the importance of sound fundamental education in mathematics and science before embarking on higher education in engineering, with the need for further improvement in the British standard in this regard, and post-graduate courses following a reasonable period in industry.

Questions were answered by members of the team: Dr. B. N. Cole, Mr. H. E. Dance, Dr. H. L. Haslegrave, Mr. G. S. C. Lucas, Mr. P. E. Sleight, Mr. E. G. Sterland, Professor A. S. T. Thomson, and Mr. W. K. Brasher, who summed up the discussion, particularly in regard to the comparison between the Russian and British systems of engineering education. It was mentioned, moreover, that when a return visit was paid by a Russian team in October 1956 they, too, were much impressed by what they saw of our engineering educational system. We must recognize, however, that we have not as a nation encouraged science, engineering or engineering education to the same degree as in the Soviet Union. The shortage of engineers and scientists is now a serious problem in this country. The measures which have been taken to rectify the deficiency are useful, but we cannot get the required number and quality of students unless we tackle a fundamental problem in the schools—the improvement of science teaching by the encouragement of science teachers. But although the present problem is serious it is to the future—ten or twenty years hence—that we must look with grave concern. Productive capacity in the Soviet Union is increasing rapidly. There has been a steady improvement in the standard of living, and it may be that in ten years' time Russian industry will be looking for greater outlets abroad for its production. Our export industries will meet additional and more intense competition, and, while the Russians have adequate supplies of most raw materials and food, we are dependent on imports and, to pay for them, on exports. Unless in ten years' time our output of engineers is right in both quantity and quality, the economic outlook for Great Britain will be grave indeed. C. T. M.

THE INSTITUTION'S ANNUAL DINNER

Members unite once again at Grosvenor House

THE Annual Dinner of The Institution was held at Grosvenor House, Park Lane, on the 28th February 1957. The President, **Sir Gordon Radley**, presided over a record gathering of 1 500 members and guests. The principal guest was **Sir Oliver Franks**, Chairman of Lloyds Bank and sometime British Ambassador in Washington. His speech—not at all an 'after-dinner speech' in the usual sense of the phrase—will long be remembered as an example of brilliant delivery and as an incisive analysis of an aspect of Britain's present predicament. It is reproduced below, together with those of the President, Sir George Nelson, and Dr. Charles Hill, formerly Postmaster General and now representing The Institution's landlord as Chancellor of the Duchy of Lancaster. The stories Dr. Hill told and the tribute he paid to Sir Gordon Radley made diners both happy and proud before they rose from the tables to make their individual reunions.

Among those present were:

His Excellency Monsieur S. Tuomioja (*Ambassador for Finland*); Dr. the Rt. Hon. Charles Hill, M.P. (*Chancellor of the Duchy of Lancaster*); The Rt. Hon. the Viscount Hailsham, Q.C. (*Minister of Education*); The Rt. Hon. Lord Mills, K.B.E. (*Minister of Power*); The Rt. Hon. Ernest Marples, M.P. (*Postmaster General*); Admiral of the Fleet the Rt. Hon. the Earl Mountbatten of Burma, K.G., G.C.B., G.C.S.I., G.C.I.E., G.C.V.O., D.S.O., LL.D., D.C.L., D.SC. (*First Sea Lord and Chief of Naval Staff*); The Rt. Hon. the Earl of Mount Edgcumbe, T.D. (*Past-President: Honorary Member*); The Rt. Hon. the Viscount Chandos of Aldershot, D.S.O., M.C. (*President, The British Electrical and Allied Manufacturers' Association; President, The British Electrical Development Association*); The Rt. Hon. the Viscount Falmouth (*Honorary Treasurer*); The Rt. Hon. Lord Brabazon of Tara, G.B.E., M.C. (*President, The Royal Institution of Great Britain*); The Rt. Hon. Sir Oliver Franks, G.C.M.G., K.C.B., C.B.E., M.A.; Sir George H. Nelson, BART. (*Immediate Past-President*); General Sir Brian Robertson, BART., G.C.B., G.B.E., K.C.M.G., K.C.V.O., D.S.O., M.C. (*Chairman, British Transport Commission*); Sir Noel Ashbridge, B.SC.(ENG.) (*Past-President; Honorary Member*); Sir Ben Barnett, K.B.E., C.B., M.C. (*Chairman, Commonwealth Telecommunications Board*); Sir Harold Bishop, C.B.E., B.SC.(ENG.) (*Past-President; President, The Association of Supervising Electrical Engineers*); Air Chief Marshal Sir Dermot A. Boyle, G.C.B., K.C.V.O., K.B.E., A.F.C. (*Chief of the Air Staff*); Professor Sir Lawrence Bragg, O.B.E., M.C., F.R.S. (*Fullerian Professor of Chemistry and Director of the Davy Faraday Research Laboratory, The Royal Institution of Great Britain*); Sir Frederick Brundrett, K.C.B., K.B.E. (*Chairman, Defence Research Policy Committee and Scientific Adviser to the Minister of Defence*); Sir David Brunt, M.A., SC.D., F.R.S. (*Secretary, The Royal Society*); Sir Josiah Eccles, C.B.E., D.SC. (*Past-President*); Sir John Dalton; Sir Harold Emmerson, K.C.B., K.C.V.O. (*Permanent Secretary, Ministry of Labour and National Service*); Sir Archibald J. Gill, B.SC.(ENG.) (*Past-President*); Sir John Hacking (*Past-President*); Air Chief Marshal Sir Donald Hardman, K.C.B., O.B.E., D.F.C. (*Air Member for Supply and Organization*); Sir Graham Hayman (*President, The Federation of British Industries*); Sir Laurence Helsby, K.B.E., C.B. (*First Commissioner, Civil Service Commission*); Sir Edwin Herbert, K.B.E., LL.B. (*President, The Law Society*); Sir Godfrey H. Ince, G.C.B., K.B.E. (*Chairman, Cable and Wireless Ltd.*); Lt.-General Sir Ian Jacob, K.B.E., C.B. (*Director-General, British Broadcasting Corporation*); Sir Gilmour Jenkins, K.C.B., K.B.E., M.C. (*Permanent Secretary, Ministry of Transport and Civil Aviation*); Sir Henry Jones, M.B.E. (*President, The Institution of Gas Engineers*); Sir David L. 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Two Corporate Members talk to each other before dinner

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Parker (*Member of Council*); D. S. Parry (*Chairman, Northern Ireland Centre*); A. A. Part (*Under-Secretary, Ministry of Education*); Rear-Admiral K. H. T. Peard, C.B.E. (*Director, Naval Electrical Department*); H. N. Pemberton (*Chief Engineer Surveyor, Lloyd's Register of Shipping*); Dr. A. I. Petrusevich (*Counsellor of the Soviet Embassy*); J. S. Pickles, B.SC. (*Chairman, South of Scotland Electricity Board*); Professor G. H. Rawcliffe, M.A., D.SC. (*Chairman, Western Centre*), R. W. C. Reeves (*Chairman, The Cable Makers' Association*); B. G. Robbins, M.SC.(ENG.) (*Secretary, The Institution of Mechanical Engineers*); V. A. M. Robertson, C.B.E., M.C. (*Chairman, The Association of Consulting Engineers*); H. Robson, B.SC. (*Chairman, Southern Centre*); J. R. Rylands, M.SC., J.P. (*President, The Institute of Fuel*); P. J. Ryle, B.SC. (*Chairman, Supply Section*); D. P. Sayers, B.SC. (*Member of Council*); R. Somerville, C.V.O. (*Clerk of the Council, Duchy of Lancaster*); H. Stanesby (*Past-Chairman, Radio and Telecommunication Section*); R. L. Stanley (*Hon. Secretary, South-West Scotland Sub-Centre*); P. d'E. Stowell, B.SC. (*Chairman, Mersey and North Wales Centre*); Dr. G. B. B. M. Sutherland, F.R.S. (*Director of The National Physical Laboratory*); D. Taylor, M.SC., PH.D. (*Chairman, Measurement and Control Section*); G. I. Thomas, B.SC. (*Hon. Secretary, South-East Scotland Sub-Centre*); S. Towill, B.SC.(ENG.) (*Hon. Secretary, Mersey and North Wales Centre*); J. A. Walker (*Hon. Secretary, Sheffield Sub-Centre*); H. West, M.SC. (*Member of Council*); Major-General M. S. Wheatley, C.B., C.B.E. (*Signal Officer in Chief, War Office*); G. A. Whipple, M.A. (*President, The Scientific Instrument Manufacturers' Association*); R. C. G. Williams, PH.D., B.SC.(ENG.) (*Chairman, Radio and Telecommunication Section*); The Rev. Preb. E. H. Williams-Ashman, M.V.O., M.A. (*Acting Chaplain to the Council*); Dr. H. F. Willis, M.SC. (*Chief of the Royal Naval Scientific Service*); R. Wright (*Hon. Secretary, Madras Oversea Committee*); T. S. Wylie (*Hon. Secretary, Northern Ireland Centre*); H. T. Young (*Past-President*); and W. K. Brasher, C.B.E., M.A. (*Secretary*).

The dinner began with grace said by the **Rev. Prebendary E. H. Williams-Ashman,** Acting Chaplain to the Council.

The Loyal Toasts were proposed by the **President** and duly honoured. He then rose to make an announcement in the following words:

'To-day is the birthday of our oldest Past-President, Sir James Swinburne, BART., F.R.S., who presided over a

Industry greets power—Sir George Nelson congratulates Lord Mills in the ante-room of Grosvenor House

similar function to this no less than 55 years ago. Sir James is 99 to-day. He first became a member in the year 1885. He had a distinguished career as a consulting engineer and as an expert witness on electrical and allied matters. It was said of him that no one could surpass him for his candid, amusing but nevertheless far-seeing utterances in discussions at Institution meetings.

'Our records of the Annual Dinner in 1902 state that the popular President proposed the usual Loyal Toast in his characteristic style, and that the toast of The Institution was given by a leading King's Counsel, who made some frivolous references to the assistance rendered to the legal profession by electrical engineering litigants and paid a compliment to Mr. Swinburne (as he then was), who was well known as a witness to Bench and Bar alike.

'I should like the agreement of my fellow-members to sending a congratulatory greetings telegram to Sir James. I propose that the following telegram should be dispatched:

Fifteen hundred fellow members and guests of The Institution, assembled this evening at the Annual Dinner, send you as their senior Past-President heartiest congratulations on your 99th birthday to-day, and their best wishes for your health and happiness during your hundredth year and after.'

The proposal was agreed with acclamation and the President went on to say: 'The telegram shall then be sent, and all the resources of the Post Office will be devoted to seeing that he receives it.'

Next, **Sir Oliver Franks** proposed the toast of 'The Institution of Electrical Engineers'. He said:

'In a way, I feel a little embarrassed at this moment.

A happy smile from Professor Sir Lawrence Bragg as he is welcomed by Sir George Nelson

A conversation piece before dinner; Viscount Falmouth, Mr. E. H. Ball and Professor E. B. Moullin

In this country we have a very eccentric system of education, and I feel that I have suffered from it. I know something about words and nothing at all about figures; a little about language but nothing whatever about the physical sciences; a bit about the story of mankind but nothing whatever about nature and its works. Perhaps I know something about the past, but you, the members of this Institution, are people who shape the future, so that while I am concerned with ideas, you, with your many inventions, are altering the world.

'I want, with your permission, to speak for a minute or two about a paradox in the world, a paradox which worries me. It is this. I suppose that there is no great profession in the world which has done nearly so much as you electrical engineers to bring the nations closer together, to promote unity, to find ways and means of enabling people to live together, talk together and work together. You have brought light where there was darkness. I think that I remember someone once mentioning the name of Edison to me. But you have done much more than that; you have made communication across the whole world easy, if not cheap, and so quick that to someone like me it seems instantaneous. I suppose that without you the ships that cross the oceans, the aeroplanes which go so fast through the skies, would none of them move. You bring us together, you unite us; but just look at what in our lifetimes the world has been doing!

'Let me put it in rather a superficial but dramatic way. Taking the last hundred years, for more than half that period, the earlier part of it, the whole world had one great political capital: London. I do not mean that everything was run from here. Far from it. But if you looked for the place where the great decisions were taken, where the general course of affairs was influenced, where the policies were laid down that policed the seas and kept the peace, it was here.

'By the time we had come to the end of the First World War we had not one world capital but two: London and Washington. By the time we had come to

the end of the Second World War there were three: London, Washington, Moscow. By the time we had come to the end of the Korean War there were five: London, Washington, Moscow, Peking, Delhi. After thirty-five years, five world capitals instead of one.

'Our fathers thought that what was done in our part of the world—the ideas that we had, the laws that we used, our habits, our institutions—all the other peoples of the world in time would gradually come to copy, to imitate, to use themselves. The pattern was here, the centre was here, this was the focus. To-day, there are five places in the world to which different groups of nations are attracted—five places which set patterns. The laws and the institutions that the other places have are different from ours: they set a different pattern, they look different ways. The world has become fragmented, one might say, into five parts. That is what has happened to the world which you are unifying!

'Have you thought just what difference that makes? I suppose that thirty-five or forty years ago we were quite sure that our part of the world—this Western world, the nations on the two sides of the Atlantic, the Western European nations and the nations of North America—was somehow responsible for the destinies of things and that it was up to us to try to be sensible in running them. But to-day there are four other centres in the world each thinking how they will run things, how they will order matters, what institutions they will promote, what ideas and what policies they will favour; and so to-day we live in a world of differences, a world of contentions, a world at times of enmities, that our fathers never knew. For our part of the world, for this North Atlantic civilization of which we are part, there has been a very great change, since all round us are great areas of the world that no longer look to us when they look for guidance.

'What a change there has been too in our North Atlantic civilization itself. Think of the comparative exhaustion, the comparative chaos, of Western Europe; think of the strength, the vigour and the power, political and economic, of the North American continent. There has been a vast displacement of gravity, and we have seen it all happen in this last thirty, this twenty, this ten years. All this has happened, and we live in the centre of it and have to make the necessary adjustments.

'Our country in the whole of my adult lifetime has been making these adjustments, and on the whole quietly, skilfully and well. Sometimes the adjustments have come upon us and sometimes we have initiated and made them ourselves. Usually they have been quiet and relatively unnoticed; sometimes they have been dramatic, short in time and clear for all of us to see. That happened in 1947, when suddenly the Indian Empire dissolved, and the British Indian Army, that had kept the peace from Singapore to Aden and the eastern coasts of Africa, ceased to be. In its place there suddenly appeared independent nations, members of our Commonwealth. That was such an adjustment, a great change in our story and in our responsibility, a successful change but one which was dramatic in its suddenness.

'There is also what happened in the last few months of last year. The Suez affair was such another dramatic adjustment. I hope I shall say nothing this evening which rakes over or disturbs any of the hot embers of controversy. That is not my intention; but I want just for a moment to refer to one or two of the things that remain now that that affair is over.

'There is an adjustment which we are having to make because of what happened. I suppose that before it our influence was perhaps the most important single influence in the Middle East, and I suppose, too, that to-day it is not. To-day in the Middle East the two great powers in the world which live in tension with each other, the United States and the U.S.S.R., look at each other across the Middle East as they did not at the beginning of 1956. When the physical things that concern the Suez affair are over and done with, what we are left with may be a tension the greater because our influence has been diminished. We may find that still more of the world is divided by that curtain which separates the East and the West. We may also find that the adjustment which we have to make in our country is difficult.

'Looking at the position at home, in the autumn of last year it seemed as though we were conquering our domestic difficulties, the ones that I know a little about, the difficulties of inflation. It looked then as though by the spring of this year we should find that inflation was over and the economy back in balance, that our reserves were in good shape and the Government could begin to relax, that investment could go ahead, that we were on an even keel and could plan for the future.

'You remember, however, that in November and early December there was a crisis, a crisis of money, a crisis of the reserves, which began to run out so suddenly and rapidly that it required drastic action to stop the flow and hold the position. You remember that we found that we were able to do that. We were able to borrow from the International Monetary Fund and the Export-Import Bank so many hundreds of millions of dollars that the immediate apprehensions of the world about sterling were stayed, so that we got back for the time being onto an even keel and no longer had cause for immediate worry and immediate anxiety.

'What I want to say to you is this. There is no crisis now; there are no headlines in the newspapers, and there need not be: but there is a problem to be solved. If you bring out all the stuff you keep in the back drawers and put it in the shop window—and that is what we did in the middle of December—that is a once-for-all operation; you cannot do it again. What, therefore, we as a nation have done is to buy time. We have bought time—twelve months, or perhaps twenty-four—and we have to use it. If we do not use it we shall have bought it in vain.

'When to-day we look at the nations of the world, our friends across the sea who are looking at us, I am reminded of the last lines in that strange poem of Browning's, "Childe Harold to the Dark Tower Came", in which the knight comes to a land haunted by strange sights and sounds, and reaches at last a great plain. The

sunlight begins to die and he sees the hills at the edge of the plain outlined sharply against the sky. To his imagination those hills seem like giants, chin in hand, watching, watching. . . .

'I am not saying that that exactly applies to us; I am only saying that it is what came into my mind when I thought about this. The nations of the world are watching. They are watching how we use the time we have bought—it matters a very great deal that we use it well. We can look, we independent citizens, to our Government for a great deal. We can look to them to realize that the policies and plans which were all right six months ago will not do any more. We can believe that they will be resolute, and I think enterprising and novel, in what they set out to do. They will have to be. They have a new situation to meet.

'I am quite sure, however, that there is a fairly early limit to what the Government alone can do. In this sort of situation, with a problem which needs a firm eventual solution, it will require the efforts of the people of this country if the answer is to be adequate and lasting and sure. And the people of the country are you and I. You, the members of a very great profession—many of you directly serving in one of the great modern industries of this country, and others of you standing at one remove from them, helping them in various ways, by research or advice—you have a responsibility. You have the responsibility to see that your operations in the industries which you guide and lead and inspire are fitted to this problem and its ultimate solution. It means that the need for efficiency at home and more exports abroad is greater, not less. The foreign currencies that we earn will mean, at the end of the day, food for our stomachs and work for our hands.

'I too, a banker, have my responsibility. I think that it is to combine with the caution which any banker must use—because he is using his depositors' money, other people's money—initiative in finding safe yet enterprising ways of using money to help industry and enable it to do its job. I am talking about pedestrian things, the ordinary business of the electrical profession, the ordinary business of the electrical industries, the ordinary business of banking; but these things are what our problems—the problem of our economy, the problem of inadequate reserves, the problem of the crisis of last November and December—are about. It is no use saying that "they"—"they" in Parliament and in Whitehall—can do it all. They can do a good deal; they can lead; but in the end it rests with you, as it rests with me, in our capacity as ordinary people of this country.

'And so, Sir, I want to suggest to you this evening that what lies ahead of the electrical engineers and of the other citizens of this country is a realization of the fact that in this last month or two we have not achieved something but merely put ourselves into a position to begin to achieve something, and that it matters very much what we do.

'I salute this great profession, and still more I salute your Institution. It is at once a learned society and the guardian and maintainer of the standards of your profession. As it has flourished in the past, so I hope that it may have in the future many years of prosperity and success as it serves the industries and laboratories of this country, engaged in mastering what to me will always be that strange and mysterious phenomenon, electricity.'

Sir Gordon Radley, the President, spoke in response as follows:

'I always consider that it is a great privilege and a great responsibility to respond to this toast of "The Institution". It is the more so to-night, in the presence of this great company of members and their friends.

'I do not know whether my fellow-members have observed a President's progress towards the chair which I now occupy. I started many years ago a long way away at the far end of this top table. The following year I was at the other end, only a little closer in. So it goes on from year to year, first one side and then the other, but always getting a little closer, until for one short evening he occupies this chair—in engineers' terms, a highly damped oscillation. But during the last few cycles of that oscillation, he has been praying "What shall I say to them?"

'For during the years of my novitiate I have listened to men who are leaders in other walks of life, in letters and in law, in the arts and in war, to prelates of the Church and a Prince of our own Royal House, speaking of this Institution of ours. To-night we have as our principal guest one who has been a professor of moral philosophy, and our country's ambassador in the United States, and who is now chairman of one of our greatest banks. I leave to Sir George Nelson, who knows him better, the privilege of thanking Sir Oliver for coming to us this evening. I would thank him for the toast which he has proposed and for what he has said to us in doing so, words of wisdom which I am sure that all of us will ponder.

'And now I, as an engineer, must reply to him. Some time ago, the local plumber, having been summoned to effect some repair, said to my wife: "Tell your husband, mum, that corrosion was the cause of your trouble. He'll understand what I mean; he's an engineer—of sorts." As an engineer—and now, I am very much afraid, only one of sorts—I must reply for my 40 000 fellow members.

'In doing so, I should start by giving some account of my charge. As we all know, in these days the scientists are pushing out the frontiers of knowledge very rapidly into the unknown. We can no more control the pattern of scientific discovery than command the results from the research laboratories. Engineers are following hard behind, developing entirely new technologies. It is in this changing world that The Institution must play its part. It did so when, together with its sister Institutions, it promoted a technical get together of the established sciences and the newer technologies in the British Nuclear Energy Conference, which I think has not been unhelpful in giving this country recently a world lead in

the application of nuclear energy to the land-based generation of power.

'But let us not, in this process of keeping up with the scientific Joneses, develop into a closed shop, talking to one another in a language which is all our own, composed of technical terms and mathematical expressions; sometimes, I fear, with a sense of knowing a little bit better than the rest of the world. I like to think that one of the principal branches of electrical engineering is communication. I may be mistaken. But if you believe, as I do, that the electrical engineer has something of value to offer to his fellow-men, then we ought surely to develop the art of communicating our ideas to those who do not necessarily speak our language. The Institution as a whole has always attached great importance to this. As an example of what we are doing there was the Faraday Lecture only a fortnight ago in a packed Central Hall, where Dr. Allibone talked to an audience of non-specialists about "Nuclear Energy in the Service of Man."

'The responsibility, however, is not only a corporate one of The Institution; it is an individual one. I believe that the way to interest the younger generation in electrical engineering is to tell them of some of the things that engineers are doing. The Press could help here, but I am afraid that, even in this technological age, engineering achievements have not always the news value which we should like them to have.

'It is not, however, so much of The Institution that I would speak this evening, but of the engineer, and in doing so I would distinguish between the engineer and the scientist. British scientists have given us a fair start. The key to the release of energy from the atomic nucleus was first turned in the Cavendish Laboratory. Appleton, working in various laboratories, gave us the basis of what we know about radio transmission by way of the upper atmosphere. The development of the jet engine was not unconnected with work in Government experimental establishments. Polythene was developed by chemists in an industrial research laboratory.

'The new knowledge of the physical world that is being very rapidly accumulated, and the new materials which the chemists are producing for us, are the sort of things that engineers can use. The fact that the Chancellor of the Duchy of Lancaster is to speak later makes me feel that I am taking some risk in reminding you of the professor at the medical school who was saying farewell to a class of students about to become doctors. He wished them well on entering their profession. "Gentlemen," he said, "I have done the best that I can for you; I have told you all I know. But, now that you are leaving me I have a confession to make: only half of what I have told you is true." There was a pause. "But, gentlemen," he went on, "it is worse than that; I do not know which half was true."

'Before I go further, I should like to take advantage of this opportunity to say how much we in the Post Office appreciated Dr. Hill's reign as Postmaster General. He gave us much encouragement and support. Perhaps that is rather too static a word. But, if he refused to recognize the word "plant" as having anything other than a biological meaning, we did under his leadership put many new cables into the ground and start building many new telephone exchanges as a means for giving telephone service on an increasing scale. We all hope that that good work will go on under our new Postmaster General, Mr. Marples, whom we are also glad to have in our company to-night.

'The future of this country depends very largely on engineers. Too often the United States, with its armies of engineers—though it has only three times our population to draw upon—beats us in putting onto the world market what are really the results of work by British scientists. Russian engineering of nuclear reactors is at a surprisingly high level. In their planning for the bulk transmission of power at voltages approaching a million volts the Russians are very well in advance.

'These things are of some importance. They are of all the greater importance because these other countries have vast natural resources behind them which we have not.

'We are too few for the tasks that lie in front of us. A great deal has been said about the shortage of engineers, and I do not propose to add to it. I should like to remind you that our Institution, in carrying out that function to which Sir Oliver referred, has been unwavering in its insistence that those engineers who are produced under the expanded facilities for technological education should be adequately prepared. Here let me say how glad we all are to see Lord Hailsham here this evening in his new capacity as Minister of Education.

'In listening to Sir Oliver, I have become more and more seized of the thought that we who are engineers may not be sufficiently aware of the urgency of our tasks. In this age of rapidly increasing scientific possibility, ten years between the birth of a new idea and the putting of equipment into service is a long time, whether it is a new aircraft design or an electronic telephone exchange. We, together with our American colleagues, took great risks with the first transatlantic telephone cable, risks which, unfortunately for some of us, still exist in the form of 400 valves and about 7000 other components working at the bottom of the Atlantic. Even greater risks were accepted when the courageous decision was taken some years ago to go ahead and build Calder Hall.

'This island of ours emerged as a first-class power during the first Elizabethan age, with a way of life which has become peculiarly our own and which we cherish. To-day, in this second Elizabethan age, that situation, as you have heard, is in some peril. We owe much to our forefathers, the seamen of the sixteenth century, who staked a claim for us in the world *geographic*. In this twentieth century we who are engineers must with equal boldness stake a claim for Britain in the world *scientific*. Let us not forget that our material wealth is in what we equip ourselves to produce—in the power that we generate for industry, in improved transport and communications, and above all in the machines, the products of our brains, which the world should want to buy from us.

'But even in this electronic age the utmost that we can do is inadequate if it does not extend beyond engineering. The presence here this evening of so many distinguished guests who have served in other walks of life is evidence that The Institution recognizes this. The engineer has a part to play on a stage on which there are many other players. But it must be part of a story in which wisdom walks with increasing scientific knowledge and with a belief in the future and in man as the dominating motives. And so, Sir Oliver, once again I thank you for this toast which you have proposed, and I thank you all for the way in which you have received it.'

Sir George Nelson, Immediate Past-President, in proposing the toast of the guests, said:

'When I was a small boy—and I am reminded of this by the reference which the President has made to our oldest Past-President's 99th birthday—there was a song which went: "Old soldiers never die, They only fade away." I do not know the fate of all our Presidents, but I am much impressed by the graciousness of the Council in allowing the Immediate Past-President to propose the toast, in the year following the completion of his year of office, of the guests of The Institution at the Annual Dinner, and that is my privilege and pleasure to-night.

'It is a great pleasure, because there are so many of my personal friends here, and one in particular, our principal guest. It has been the custom of The Institution for some years to ask distinguished and able men from other professions and walks of life to come and address us. Never has the wisdom of that policy been more in evidence than to-night, although we have had here some of the greatest men in the country. The speech which we have heard from our principal guest, Sir Oliver Franks, is of great importance to all of you in this room, and not only to you but to everybody in this country.

'It is easy for us to be immersed in our theoretical and business life and not have the opportunity to study the realities with which we shall be faced in the future and those which face us to-day. Sir Oliver has clearly indicated to us what they are. We are most grateful to you, Sir Oliver, for what you have told us, based on your studies of moral philosophy and of the services which you have given to this country. In the office which you now hold, you are helping us all by financing business both at home and abroad. We are most grateful to you for your advice, and we hope that everybody will take it to heart and play their part in finding a solution.

'I now come to our other guests, many of them very distinguished. I should like very much to refer to each individually, but if I did I should be ruining the tradition of this dinner for short speeches, and so I ask the permission of our guests to only touch on the national matters with which they are concerned.

'First I would mention H.E. the Ambassador of Finland and the other diplomatic guests who are here. We welcome you, we admire you for leaving your country and coming to ours, so helping to weld our countries together both economically and in working for peace. I have been to Finland and have a great admiration for the country and its people. I thank you, Your Excellency, and the other diplomatic guests for their presence.

'Next I should like to refer to the members of Her Majesty's Government who are here and to thank them for their presence. We know the efforts which they are making, first of all to preserve peace, secondly to improve our prosperity, and thirdly to add to the happiness of this country, and they have our full support.

'Many may not remember, or perhaps not even know, what Milton said in the middle of the seventeenth century. He said: "Let not England forget her precedence of teaching nations how to live." How inspiring that statement is to-day! We are a great gathering of engineers here; there are 1 500 of us here to-night, representing the 41 000 members of The Institution. We hope sincerely that when you go home to-night you will realize that when a body of electrical engineers get together they need not be expected to be "operating against the public interest."

'I now turn to the members of our permanent Civil Service and their scientific advisers. We welcome them gladly, and I thank them on behalf of many members of this Institution for their co-operation in enabling us to serve our country. They can rely completely on that spirit being shown by all the members of The Institution.

'Next I come to our guests from the Services. I cannot do better, in thanking them for their presence, than refer to Lord Mountbatten, who told me to-night that he became a Corporate Member of The Institution by examination thirty years ago. I say to him on your behalf that we are very proud to have a Corporate Member as First Sea Lord. The other members of the Services who are present we also welcome gladly. Scientific and engineering developments have brought us closer together. We have the greatest pride in trying to serve you. We thank you for the help you give us in placing our ability at your disposal and for carrying the responsibility which you bear for the defence of our homes, if necessary, and for those of our Commonwealth.

'We have with us representatives of kindred societies, of universities, of schools and of scientific institutions. We work with you regularly and we are grateful to you for the co-operation which you give us, particularly in regard to the appeals which we and you are making for more and more scientists and engineers to deal with the problems of the future, on the solution of which the greatness of this country depends.

'We have with us also representatives of the nationalized industries. We are proud to help them in their work; we are proud to tackle the problems which they bring to us, and we hope and indeed are sure that we contribute to the success they are achieving in finding solutions.

'I come now to the guests of all our members. We welcome you all at our dinner. We hope that you will carry away happy memories of it and make widely known the words of our principal speaker, Sir Oliver

Franks. We wish you all well in whatever walk of life you are engaged.

'Lastly, it is my duty and pleasure to couple with this toast the name of Dr. Charles Hill, Chancellor of the Duchy of Lancaster and a member of the Cabinet. We welcome him and thank him for sparing the time to come and dine and wine with us. We have the greatest admiration for his profession; we look upon the medical profession as the greatest engineering profession of all, particularly in the field of maintenance. When he agreed to reply on behalf of the guests he was the Postmaster General, the chief of our worthy President. He comes to-day into the lives of all of us, because the Institution building stands on the land of the Duchy, so that he is our landlord. We wish him joy in his work and we are quite sure that he will be of great assistance to his colleagues in the Cabinet.'

The reply to the toast was made by **Dr. the Rt. Hon. Charles Hill,** who said:

'It is my heavy responsibility to reply for the miscellany of distinguished guests whom you, Sir George, have described, and I do it with an unusual timidity. Sir Oliver Franks began his speech by describing the embarrassment that he felt at his lack of scientific instruction, and then went on, as philosopher and diplomat and banker, to give us a broad, widely ranging view of world problems, rich in eloquence and not devoid of a few tantalizing assertions. My own embarrassment is much greater. When you asked me, Mr. President, to join you to-night and to respond to this toast I accepted in the knowledge—or what I believed to be the knowledge—that as Postmaster General I could rely on the Director General of the Post Office for a brief, one which would be sparkling with technicalities, from subscriber trunk dialling to v.h.f., from Telex to p.b.x. ("p.b.x." has always puzzled me). On the other hand, you might well have invited my colleague Lord Mills, the Minister of Power, for he would have come richly charged with a scientific brief, with plenty of ohms and volts and megawatts, and could have looked learnedly on those of us who were innocent of the meaning of such words with a mixture of post-prandial pride and electronic superiority. My good friend Quintin Hogg, Lord Hailsham, the Minister of Education, could have come with a pedagogic brief dealing with the problems of 11+ or the mystery of mixed infants, though I suspect that the eloquence of Sir Oliver Franks would have led him to throw that brief away and go into vigorous and brilliant battle with him.

'But, Sir, as things have turned out I am left to my own resources. The Duchy did give me one word of advice. "Whatever you do," they said, "don't allow their hospitality, that warm and friendly feeling that comes from the generosity of those liquids with which it will be associated, to lead you into a discussion of an extension of the existing lease at the same price." I am therefore thrown not only on my own resources but on my own impressions.

'Dare I say that seeing this great company in this great hall reminds me in at least one respect of a meeting which I once addressed in a vast works canteen in my constituency. I recall the first time when, seeking to give up a steady life for a hazardous one, I addressed a political meeting there. It was not going too well, and, as I was warming to my work, I was horrified to see four men sitting in the front row of that great canteen impervious to the wisdom which was pouring over them, insusceptible to an eloquence which was well-nigh exhausted, calmly playing a game of solo. Not one looked up; "prop and cop" and saucy misères were all that interested them. As if to rub salt into the wound, I subsequently learnt that there was a photograph in the local newspaper, taken at that same meeting at which I was perspiring with oratory, in which one member of the audience sitting at the back of the hall was seen to be

Dr. Charles Hill amuses the diners—a study in facial expression at and near the high table

engrossed in a volume which he was reading. The photograph made it clear that that volume was "Forever Amber". How can politics compete with passion?

'But, Sir, enough of this frivolity. I can only blame Sir Oliver Franks for starting me off. There is one thing that I do want to say, and I am not going to be deterred from saying it by the kindly remarks that Sir Gordon Radley has made about the immediate past Postmaster General. I want to say a few words about Gordon Radley himself, for, after all, his success as Director General of the Post Office is a matter of profound importance to your profession. He is the first engineer ever to be appointed Director General of the Post Office. There are still those who believe that when you are searching for administrators you should look not at those of specialized or scientific or technical education but only at those who have studied in what they regard as more cultural and more academic fields.

'Sir Gordon Radley has been an unqualified success as Director General of the Post Office. I was a new and green Postmaster General when I first saw him as Director General designate—tall, short-sighted, diffident, and, I thought, malnourished as well. I was before long to know him not only as able, not only as kindly, not only as unassuming, but as a first-class, clear-headed administrator of that vast undertaking. I do want to-night, if I do nothing else, on my own behalf to pay an unqualified tribute to Gordon Radley, whom you have recognized in his own professional field by electing him as your President, but whom you should know has proved a full and unqualified success in the administrative field. I shall not speak of his personal qualities, because you know them well.

'No Minister goes to the Post Office, and, I think, no engineer has an association with the Post Office, without acquiring a warm affection for that great organization. I want to say to-night that the Post Office thanks your profession for Gordon Radley, who is doing a magnificent job there, and, what is more important, has demonstrated what all suspected—that first-class administrators can be drawn from the ranks of scientists and engineers no less than from the other professions in the community.

'Finally, let me do what I got up to do, and that is thank you on behalf of all your guests for your generous and friendly hospitality to-night, a hospitality that we have all enjoyed.'

ACOUSTICS OF LARGE ORCHESTRAL STUDIOS AND CONCERT HALLS 534.846

The reason why some concert halls give splendid tonal rendering while others, though often painstakingly designed, are acoustically poor has puzzled architects and engineers for many years. The authors of this article, who are with the British Broadcasting Corporation, were given the task of modifying the B.B.C. orchestral studios for optimum acoustic performance, and they have carried out extensive investigations of well-known buildings in this country and abroad. This article is based on their Radio and Telecommunication Section paper (No. 2297) with the same title, which was published in March 1957 in Part B of the Proceedings.

T. SOMERVILLE, B.SC., F.INST.P., MEMBER
C. L. S. GILFORD, M.SC., F.INST.P., ASSOCIATE MEMBER

SYMPHONIC music figures largely in the programmes of the sound service of the B.B.C., and because this type of music is written to be performed in large halls it is essential, as far as possible, to reproduce in large orchestral studios the acoustics of concert halls. For this reason the B.B.C. has carried out many investigations in concert halls in this country and abroad, to discover the essential characteristics and ways of reproducing them. To get the best possible results it would be desirable to use orchestral studios as large as concert halls, if this were economically feasible, but a compromise must be made, and orchestral studios are, therefore, made only sufficiently big to give a satisfactory performance.

In Great Britain it has been possible to make detailed acoustic measurements in all the important concert halls, in addition to listening tests, to decide which halls have the best properties. Such measurements have not been possible abroad, but listening tests have been carried out which show good agreement between the concert halls in Great Britain and abroad which have similar architectural features.

It is not generally known that skilled observers can assess the acoustic characteristics of enclosures by simple listening tests. For example, excess or deficient reverberation at particular frequencies can be detected, and it is quite easy to recognize the harsh tone produced by sound decays which are not smooth. Much can be learnt about an auditorium by closing one ear and moving around, because with monaural hearing the normal directional capabilities are inhibited, resulting in the subjective emphasis of acoustic faults. This, of course, is equivalent to the condition in a broadcasting studio, or in a concert hall when a microphone is being used, and is the reason for the difficulty in obtaining acoustics good enough for broadcasting. If diffusion is good, there will be little variation in the sound field and it should be possible to hear all the parts in an orchestral performance. Conversely, poor diffusion causes the

production of pronounced standing-wave patterns, with consequent marked variations when moving about.

Investigation of many concert halls led to the conclusion that, in general, the old halls had richer tone than any of modern design. Some years ago a detailed comparison was made between the Liverpool Philharmonic Hall and St. Andrew's Grand Hall, Glasgow.[1] The Liverpool Philharmonic Hall, shown in Fig. 1, was completed just before the Second World War in place of the original hall which had been burnt down. It has a fan-shaped plan and a ceiling also shaped to direct the sound from the orchestra onto the audience. This is a characteristic feature of most modern halls, believed by its protagonists to be necessary in order to increase the sound level in rear seats. In the Philharmonic Hall the tonal quality is a little harsh, and the low-frequency instruments such as brass and percussion often sound so loud that they drown the weaker instruments such as the strings and woodwind, an effect believed to be due to the proximity of the powerful instruments at the rear of the orchestra to the reflectors, which therefore give preferential reinforcement.

By courtesy of the Liverpool Philharmonic Society

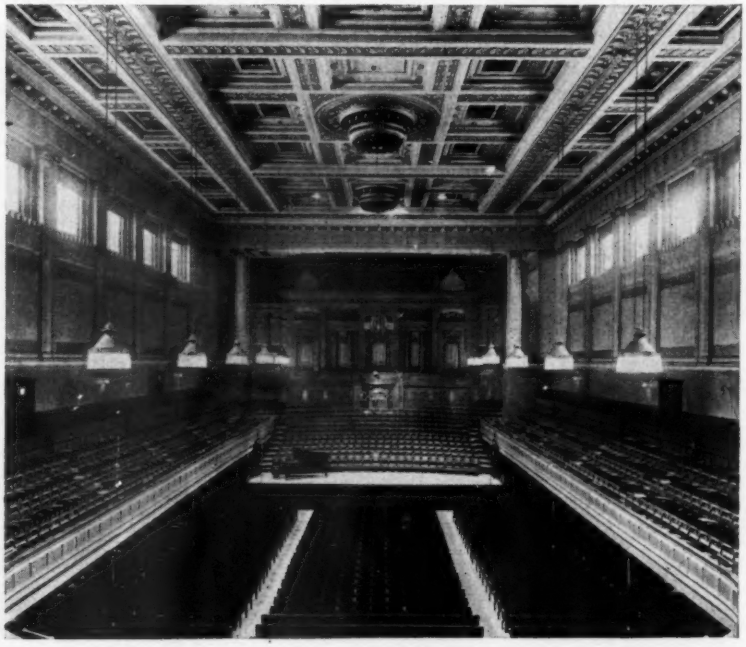
1 *Philharmonic Hall, Liverpool*

In St. Andrew's Grand Hall on the other hand, the plan is rectangular, and the ceiling is flat and coffered as may be seen from Fig. 2. The diffusion of sound is considerable, and, although there is no deliberate reinforcement by reflectors, the sound intensity at the back of the hall is high, and the tonal quality is very rich. These two halls are respectively quite typical of the traditional Leipzig hall and of the modern hall which is often shaped like a cinema. The authors know of no modern concert hall which produces entirely acceptable tonal quality, and the masking of the weaker instruments, as described above, is a feature of most of them.

The authors believe that the use of reflectors to reinforce sound in large halls is not, in fact, effective. Experiments have been carried out which show that there is little difference in measured intensity between new halls with reflectors and old halls without. This is probably because reflectors direct the sound energy onto the audience, the largest absorbing surface in a concert hall, and the reverberation time is correspondingly reduced because too little energy is reflected throughout the hall to build up reverberation. Furthermore, because the sound is being directed from the orchestra onto the audience, the conditions for good diffusion no longer exist, and apart from the lack of reverberation this may help to cause the subjective impression of harshness. In the older concert halls, where the sound is left to find its own way around

2 *St. Andrew's Grand Hall, Glasgow*

By courtesy of the British Broadcasting Corporation



the hall and is diffused considerably by the irregularities popular seventy years ago, the sound level in remote parts of the halls is quite high because the reverberant energy is much higher. An important subjective effect must also be considered in this connection. It is known that a sound consisting of direct sound plus a few reflections does not appear to be as loud as a truly reverberant sound, even if the actual measured intensity is the same.

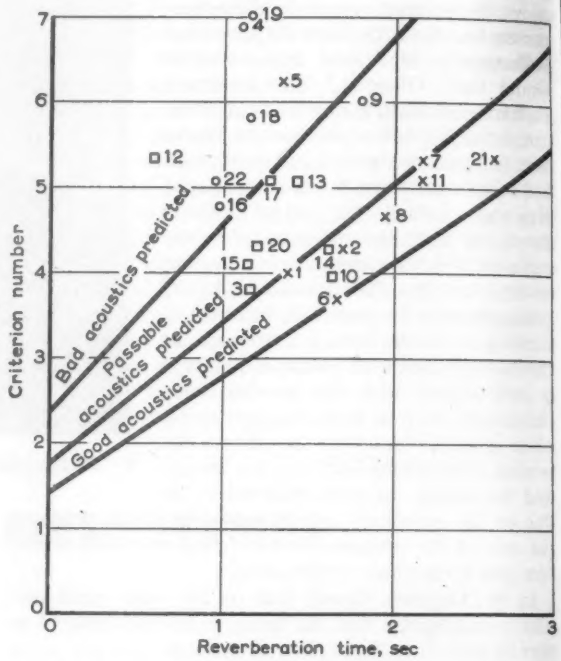
Although there is considerable difference of opinion about the desirable sound of an orchestra in a concert hall, it is generally accepted that reverberation times of the order of 1·6 to 2·0 sec are necessary for the satisfactory performance of symphonic music.

So far there appears to be no modern hall in which architects have achieved this objective, most modern halls having reverberation times between 1·5 and 1·7 sec. The authors believe that this fact is connected with the features of the design introduced to direct the sound from the orchestra onto the audience, and, for this reason alone, consideration should be given to modern versions of traditional designs.

Before designing orchestral studios to simulate the acoustics of concert halls, it is necessary to try to find out what the majority of listeners to orchestral music would prefer. It is always easy for one or two individuals to arrive at their own conclusions on the relative merits of a number of concert halls. As opinions differ considerably, the most satisfactory way would be to consult people who have listened to concerts in a large number of halls in this country and so arrive at the opinion of the majority. However, this approach has not met with much success because there are not enough people who know all the concert halls and can therefore give statistically significant answers. In an endeavour to overcome this difficulty, the B.B.C. asked members of its staff throughout the country to give opinions on all the concert halls and studios within their experience. Few individuals claimed familiarity with places outside their own particular regions, and it was clearly necessary to obtain a uniform basis for comparison between different parts of the country. However, there are in the B.B.C. five persons who know all the concert halls and studios in Great Britain, and when their opinions were compared with those in each region it was found that within the separate regions the agreement was good. It was therefore possible for the first time, in this type of subjective investigation, to obtain a reliable comparison between concert halls in the different regions of Great Britain.

To correlate this subjective information with the objective measurements which have been made in concert halls and studios in the country, an acoustic criterion was devised, as shown in Fig. 3. The derivation of this has been described elsewhere.[2] It will be seen that the agreement between the measured objective properties and the subjective characteristics is reasonably good.

The reverberation times of a number of studios and concert halls are shown in Fig. 4. The symphony orchestra studio at Maida Vale has a reverberation time of about 1·8 sec, which is, in fact, longer than the Royal Festival Hall, which has a reverberation time of only 1·5 sec with the audience present. The Free Trade Hall, Manchester, is more satisfactory than the Royal Festival Hall in most respects and has a reverberation time of

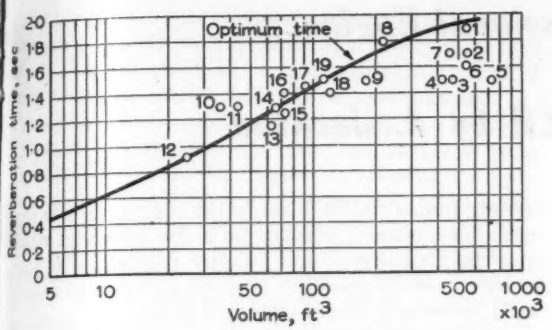


3 *Empirical acoustic criterion obtained with no orchestra or audience present*

Subjective grading:
× Good acoustics.
□ Passable acoustics.
○ Bad acoustics.

1. London, Broadcasting House, Concert Hall.
2. Manchester, Milton Hall.
3. Belfast, Studio 1.
4. Glasgow, Studio 2.
5. Glasgow, Studio 1.
6. London, Maida Vale, Studio 1.
7. Bristol, Colston Hall.
8. Manchester, Free Trade Hall.
9. London, Royal Festival Hall.
10. Liverpool, Philharmonic Hall.
11. Edinburgh, Usher Hall.
12. London, Maida Vale, Studio 5.
13. London, Camden Theatre.
14. London, Criterion Studio.
15. London, Paris Studio.
16. Birmingham, Studio 4.
17. Birmingham, Vestry Hall.
18. Belfast, Studio 8.
19. Manchester, Studio 1.
20. Edinburgh, Studio 1.
21. Glasgow, St. Andrew's Hall.
22. Bristol, Studio 1.

1·6 sec. St. Andrew's Hall, Glasgow, has a reverberation time of 1·9 sec and is the authors' preferred hall in this country, with the Usher Hall, Edinburgh, a close second, the reverberation time of this hall being 1·7 sec. The Liverpool Philharmonic Hall, which tends to be a little dead, has a reverberation time of 1·5 sec. Of the modern concert halls, the most satisfactory appears to be the Colston Hall, Bristol, which, though slightly smaller than the others, has a reverberation time of 1·7 sec.



4 Relation between optimum reverberation time and volume of hall, with orchestra and audience (where applicable) present

1. Glasgow, St. Andrew's Hall.
2. Edinburgh, Usher Hall.
3. Liverpool, Philharmonic Hall.
4. Copenhagen, Concert Hall.
5. London, Royal Festival Hall.
6. Manchester, Free Trade Hall.
7. Bristol, Colston Hall.
8. London, Maida Vale, Studio 1.
9. Glasgow, Studio 1.
10. Swansea, Studio 1.
11. Cardiff, Charles St. Hall.
12. Glasgow, Studio 2.
13. London, Maida Vale, Studio 2.
14. London, Maida Vale, Studio 3.
15. Belfast, Studio 1.
16. Birmingham, Carpenter Road Studio.
17. Manchester, Milton Hall.
18. London, Broadcasting House, Concert Hall.
19. London, Farringdon Hall.

After the completion of many of the early investigations into the characteristics of old and new concert halls, the need arose to re-treat acoustically the largest B.B.C. orchestral studio in Maida Vale, London. It was decided that the pattern of the traditional concert halls should be followed as far as possible. A coffered ceiling would have been desirable, but the existing ceiling is carried on arched girders so that little could be done in this respect. Furthermore, the structure would carry very little extra weight, and all that could therefore be put on the ceiling were some light-weight diffusing elements. This studio is solidly constructed, the only bass absorption being obtained from the ceiling and the orchestral platform. It was therefore necessary to increase the low-frequency absorption by using membrane absorbers having three depths, arranged in an irregular pattern on the walls, to cover the low-frequency region. These are shown in Fig. 5. In accordance with the normal practice in traditional halls it was also decided to introduce absorption behind the orchestra in the form of choir seats, which were therefore permanently fixed in position. This studio has given very good results, the principal limitation being that with its restricted dimensions it does not give the musical impression of spaciousness characteristic of large concert halls.

B.B.C. experience has shown that rectangular studios with rectangular coffering and a reasonably high ceiling in proportion to the other dimensions usually give the most satisfactory performance in this respect. However, halls with pitched roofs, of which a few have been acquired for use as orchestral studios, appear to be generally satisfactory, giving comparable definition, tonal quality and spaciousness.

The position in Great Britain may be summarized as follows. In orchestral studios for broadcasting, every effort is made to reproduce the acoustics typical of traditional concert halls. The designers of modern concert halls, however, while acknowledging that long reverberation times are necessary, have in general not been able to obtain them. Reflectors for increasing the sound level in rear seats, although not successful for this purpose, preclude a long reverberation time while producing other bad effects, such as insufficient diffusion and preferential reinforcement of powerful instruments, with consequent poor tonal quality and definition.

References

1 SOMERVILLE, T.: 'A Comparison of the Acoustics of the Philharmonic Hall, Liverpool, and St. Andrew's Grand Hall, Glasgow', *The B.B.C. Quarterly*, 1949, **4**, p. 41.

2 SOMERVILLE, T.: 'An Empirical Acoustic Criterion', *Acustica*, 1953, **3**, p. 365.

5 B.B.C. Concert Studio, Maida Vale

Industrial Management for Professional Engineers

3. THE MANAGER AND HIS MEN *by A. Jackson*

The previous two articles in this series have considered generally the duties of a manager and discussed delegation in management. They appeared in the March and April issues of the Journal. In this third article Mr. Jackson, who is a Director and General Works Manager of the Appleby-Frodingham Steel Co., writes about recruitment, training and other facets of human relations. He states that he believes that successful managing depends on a few principles. This article is concerned with some of these and with difficulties that arise in practice, the sections on training and redundancy being especially significant.

TO-DAY the practising manager finds it most difficult to make time to write about his subject. But when he does, he may re-hash the writings of others (if he has had time to read them); he may sit back and try to discover and describe the means whereby he thinks he has achieved some success; or he may write of things which he thinks are important in the light of his experience, and which, therefore, may be new to some or may confirm the experience of others.

When a manager is a very young one, his ideal of perfection in management will probably centre on his ability to supervise the proverbial 'two men and a barrow' with maximum efficiency; many years later he will have almost completely forgotten this aspect of his career and dismissed its many difficulties as being unworthy of his consideration. He will then, no doubt, be involved in, on the one hand looking forward to plant and personnel development which will come to fruition years after he has retired, and on the other, to means whereby he can carry the whole organization to the heights of efficiency and enthusiasm, upon the success of which depends also the success of his planning for the next decade or two. His writings will now emphasize different points, mainly of interest to those already occupying or about to gain similar positions to his own.

Finally, he will retire from active service and settle down to study the ancient philosophers. From the lofty heights thus reached he will look down on the turmoil that is Industry, and ask plaintively why all management cannot become benevolent, and all workers educated to understand the economic necessities that control the future, and so work hard and happily for evermore.

The present writer has for many years been somewhere between the barrow and the stratosphere. Although his work deals directly with neither, he tries to remain aware of both. In this middle phase he has come to believe that successful managing depends on a few principles which must be consistently and steadily followed. To start something which proves to be good and then to drop it could be worse than not starting it at all.

Recruitment

Every industrial manager now recognizes how important it is to get and keep good-quality men. But because the demand is so great, there is little room for selection, and one has to make the best use of those one already has plus almost anyone who turns up.

In acquiring men for future leadership, every effort must be made to recruit from fields sufficiently wide to ensure that men of the requisite calibre are obtained. The field most closely searched comprises graduates just completing degree courses. It seems extremely popular at present for companies to compete intensively in what sometimes appears to be an effort to acquire the maximum number of these graduates, regardless of cost and of promises made for their future advancement.

This principle is to be most heartily deplored. The country—in fact probably the whole world—is short of such men, and therefore each one must be used to the fullest advantage. The present scramble tends to denude the country of teachers, thereby impoverishing the future. It further robs smaller and possibly poorer companies of the high-quality men they need, whilst those who set the price have graduates doing work which could be done equally well by labour with less training and less potential. This position is, to a degree, self-rectifying: when an organization collects too many high-level men they soon see that there is no future for them all in the one place, and some therefore leave. Unhappily, they not infrequently find they have, in the meantime, missed chances for advancement in smaller companies.

Keen young men who believe they have insufficient work to utilize fully their time and ability soon become bored. They generally thrive when they have plenty of work and the responsibility attached thereto. Before recruiting, therefore, one needs to decide how many men of high calibre can be employed to guarantee that their potential can be fully developed.

Selection

Selection methods vary widely, from a comprehensive and complicated series of interviews, to the snap decision made at a single meeting by the tycoon who can 'pick 'em at a glance'. Unfortunately for the supporters of the comprehensive system, the tycoon is very often right in selecting his candidates. This however is not necessarily

the whole point. I believe that a carefully organized and relatively comprehensive selection system is of value, not only to the company itself, in minimizing the number of bad choices, but also to those who are not accepted.

This principle may not apply so clearly to a group of candidates not employed by the firm who are being considered, but is most important in selecting for foreman or junior manager from one's own employees. Then it is imperative that all employees know they have a fair opportunity to be considered for promotion. If they also know that outside training—say in technical colleges—can be helpful, many will try to acquire this, thereby raising the level of those from which selection is to be ultimately made. Arbitrary and *ad hoc* selection methods do not tend to lead men to prepare themselves for the future, because they believe their efforts would not be recognized, and therefore they do not make them.

The first step towards selection from one's own employees is to advertise and request a reply to a comprehensive questionary. Interviewing should be by panel, which should include some seniors who know the applicants well, in addition to some who do not. A candidate who has filled in a searching questionary and experienced a properly-conducted panel interview, but has not been selected, will probably see the reasons for his failure and may even agree with the adverse decision. Arbitrary selection of one individual from a group can leave much discontent and dissatisfaction in men of potential ambition who hold the impression (even if wrongly) that they have not even been considered.

Thus, while the tycoon sitting alone may from long experience be able to select the best man on sight, his method is probably one which fails to encourage the individuals to work at their personal development, and thus selections come to be made from a lower level of ability than might otherwise be the case.

It is now also becoming fairly common for the most senior officials of companies to sit on panels selecting incoming junior staff of graduate level or thereabouts. These interviewers often make their selection almost entirely on the personality of the candidate as evinced at the time. The principle is that the future manager must be a leader, and therefore a man of evident personality. Two points are liable to be forgotten, however. First, that the kind of personality which impresses senior management may not equally impress the operative on the shop floor; and secondly, that in technical positions a recognized ability 'to do the job' is a long step towards becoming accepted as 'the boss' of the section or group.

The aim in selection should be to know the 'specification' a given job requires in academic ability, practical experience, etc. A short list of candidates may be selected on this basis, and later, at the personal interview, individual personality will lead to the final selection.

Training

Training has several aims:

(i) To add to the knowledge of the individual in respect of his present or prospective future work.

(ii) To get members of management away from daily routine into a fresh environment and there allow them time and leisure to think and crystallize past experience as a basis for future development. A desirable mental stimulus normally results from discussion with others of similar ability.

(iii) To help an individual who is about to be promoted as supervisor over those with whom he formerly worked as an equal. The training course makes a break and, if it is properly constituted, should benefit the future supervisor. To those he will soon supervise, the break alone probably evokes the opinion that he is now more capable of supervision than before he went, and thus they can more readily accept him in his new role.

Training is necessary at all levels within a company. It can be broken down into two main types:

(i) Basic training which brings its recipients to certain levels, and at these levels it is universally applicable, e.g. school leaving examinations, craft apprenticeships, university degrees, professional examinations, etc.

(ii) Training for development in the works, e.g. junior management for more senior positions, men to become supervisors, operatives to be promoted, or to be used in positions requiring new or more skills.

It is unnecessary to discuss the first group, for this type of training is largely standardized and details are well known. The second group is special training, either given within the works or directed therefrom, and it necessarily follows that management must give it the more attention. Furthermore, it is all training for advancement to a more senior position, or to work needing more or different skills. Pursuit of either of these ends usually leads to a renewal of interest in work—a vital factor in work satisfaction.

It is essential in a works that all training is for an objective. One does see training being given, often at considerable expense, for no apparent reason other than that 'it can't do any harm', or 'let's give it to the lot, it may be useful', etc. The quality and quantity of training given to each individual should depend on (*a*) an assessment of his potentiality; and (*b*) the need for the individual to be developed in relation to the requirements of the works, i.e. train for jobs, not train everybody regardless of necessity.

It is no doubt desirable that managers at all levels should help in training so that their experience can, in some measure, be imparted to their successors.

This principle is especially applicable to training men to become foremen and therefore part of the managerial staff. At this point, as many as possible of the most senior managers should give talks on their particular work and answer questions. This, I believe, is vitally important. To the man on the 'shop floor' senior managers are very far away, often being merely names, and all that is known about them is 'that they come to work at 9.30 a.m., have a jolly good time, and live very well on the backs of the workers'.

If these senior officials can demonstrate to men about to join the management team their ability and the expert nature of the work they do, and if in doing this they can make the new foreman feel that he is joining the same managerial group then in the foreman's mind the senior officials come to life. The foreman sees that a senior

official has a difficult and expert task; that he apparently has the ability to do it and that he is not afraid to be asked questions about it; and, finally, that he has gone out of his way to talk to and welcome a newcomer as a member of the management team. A man, having decided that senior management is composed of men of ability and quality, is well on the way to acquiring confidence in the company and its decisions.

Once the foreman has acquired this mental attitude, it becomes second nature to him, and obviously influences his decisions, conversations, and actions in his day-to-day routine. Faith in the competence of the company's direction and the loyalty engendered by feeling to be a part thereof are probably the most important bases upon which to build successful management.

The foreman it is who continuously represents the company on the shop floor. His attitude to the company and its policies is vital. Here, on the shop floor, are most to train, and here also the value of training can be most effective. In the general rush to train more and better managers and scientists, the potential of the average man is grossly underestimated. Here least is done where most reward could accrue.

Managers, budding managers, and technical staff are trained in the principles of management; they are exhorted to achieve leadership; many of them are trained to the highest levels of science—and the research department get so far away above the shop floor that they are out of sight in the stratosphere.

Some training—or is it education?—is vital if it is to be assured that those on the shop floor press hard upon the heels of these leaders in technical development or administration. In brief, it is necessary to have the ideas, acquire capital and plant, train operators, and then inspire them to use the plant with enthusiasm and to the utmost of their ability. To this end, education is needed in simple economics; in the relationship between productivity and the community; in the elements of social responsibility—in brief, to evoke the recognition of the relationship between work and reward in its widest sense.

The works can organize training for development, for management, for use of installed plant—but they cannot educate in the principles underlining the necessity for productivity. In the present-day industrial atmosphere, all efforts to do this are liable to be suspect as self-seeking by management. An unbiased body can help, and certain simple economic principles could well be introduced in all technical courses. It will, however, be difficult for any significantly rapid advance to be made without the support of a large body of understanding and active public opinion. At present there are too few leaders who are prepared to give vocal support to this necessity, although it is difficult to see any reason why they cannot understand it. Management can and must do what it can, but it needs wide and authoritative general support if its efforts are to assist progress materially.

Joint Consultation

The hackneyed phrase 'joint consultation' is liable to rouse the ire of many managers. There are many reasons for this with which some sympathy may be expressed, but however much one has come to dislike the phrase, no thinking person with much managerial experience will deny the fundamental rightness of the principle or its value when properly applied.

Joint consultation brings to mind 'consultative machinery', but no matter how well the machine is designed and built it will creak and grind unless lubricated. There may be many lubricants, but sincerity, goodwill and understanding alone will do a great deal to keep the machine working efficiently.

Most modern works have a series of consultative bodies such as a works council, a staff council, a foremen's council, production committees, etc. They can vary from relatively innocuous bodies which have certain minor executive functions achieved through voting after solemn discussion, to active bodies which act as channels of communication for a vital management to pass vital information to their employees and receive equally vital and useful information in return.

There is good evidence that a very large percentage of employees place 'being kept informed' very high on their list of things which promote work satisfaction, and they appear to relate this closely to security. (They both always come higher in the scale than high wages.) People are interested in the works as a whole; this interest, which grows on being fed, gives pride in the company and thus induces loyalty: this, I believe, is a major step towards continuing advancement and development.

Some people despise joint consultation as a sop to someone's foolish ideas. They ask themselves: 'What can those we supervise tell us about the way to do our job?' Not infrequently the true answer is 'quite a lot', but even supposing a supervisor does know much more than any of his men, what use is it unless he can get them to accept and use this knowledge fruitfully? And is it not easier to train a man to accept your method willingly and enthusiastically by friendly communication, instead of through rigid orders no matter how correct and how well conceived?

If a man can be encouraged to give an opinion on the way a job can be improved, it demonstrates at least two things—that he is interested in his work, and that he is thinking about it. A little friendly consultation can encourage him to keep thinking, and a little discussion may easily bring him round to your way of thinking. Maybe a long way round compared with the didactic order, but maybe not a long way round at the end of the race, because consultation and discussion may persuade him in due course that you are really good at the job, and he will then willingly, and with enthusiasm, follow your ideas.

One thing too little understood is the tremendous potential still lying latent in the man on the shop floor. If good leadership could bring this to the fore so that it was applied to the whole of industry, then this country would soon be a world power again in the industrial field, instead of steadily fading away as at present, under a

combination of leadership misguided on the one hand and uninspired on the other. Inspired management could give the necessary lead to industry and the community, and its key lies in consultation, which gives education towards a realization of the common purpose of work-people and management for the nation's prosperity.

Consultation is not committees and it is not joint management—it is a spirit which should pervade the whole organization. Its source of continued encouragement should arise from the aim of higher management to work to the best advantage of its employees. Not the foolish short-term advantage which tries to gratify every whim and wish of the agitator with no thought of to-morrow, but to work to run the plant with an efficiency widely recognized, which will ensure the future in ways which all can see, and at the same time give reasonable return to those working at present.

Everyone reads and writes that the big stick in industry has gone. This is not strictly true—one big stick has gone, but those who take advantage of this by idling and 'slow-timing' are really making another big stick for themselves, which, should it ultimately strike, will affect them with equal force to that of the stick which has gone. Managers must try to prevent this happening but they have an uphill task in present circumstances.

Redundancy

Redundancy is another topical problem and it is difficult to see how it can fail to be a problem in any modern plant. Research, work study, work-people's suggestions, changing customer requirements, and many other things, give rise to plant developments, and in consequence to redundancy. This does not always make it necessary to dismiss employees at short or even long notice, but it does involve changing jobs, fresh training, possibly a change to another and strange department, and maybe changes in earnings. Having recognized that only through redundancy in some form does industry maintain its efficiency and economy, all thinking people must recognize also that redundancy—just as much as wage rates and working conditions—needs sensible consideration. But not all people are sensible.

As redundancy implies changing jobs, retraining men, and considerable discussion, it is obvious that each specific instance should be made known to the men concerned immediately management has made its decision—in fact managers can go even further and inform their employees that they propose to study a section of plant or process, by work study or by any other method, with a view to promoting increased efficiency which would almost certainly imply changes for the men involved. In brief it can never be too early to give information of this kind and thereby start joint consultation.

If the prospective redundancy means reduced manpower, then normal labour turnover should be able to take care of it. If it only involves retraining and moving to a fresh job, then training can start far enough ahead to have a fully trained operative ready for the change.

Success depends on joint consultation in the right environment, i.e. between enlightened management and enlightened trade unions.

Managers are sometimes accused of lack of consultation and of giving practically no prior notice of change. And it is understandable that some managements have acted thus. Not infrequently, notice of possible redundancy arouses certain employees to resistance. Usually those so vocal against change are not the ones likely to be directly affected—thus they appear as unbiased altruists looking after the interests of their fellow workers. They encourage 'slow-timing', or insist on no reduction in manning or change of employment, even when such action is patently ridiculous even to the uninitiated: they create bad feeling and generally hamper the path of progress in this and in future prospective developments.

Any success they achieve merely weakens the position of the company which employs them, and in the long run they do disservice to their fellow-workers and the community which they very vocally insist they serve. The most charitable explanation for their action is that they do not understand what they are really doing. But, with this kind of background, it is not difficult to understand the attitude of the company which conceals redundancy to the last and only shows its hand in sudden and arbitrary action, on the principle that a sudden sharp shock causes least total disturbance. This, of course, is not good management, but one must appreciate the determination to take action when economics demand it.

Managers must aim by consultation and the dissemination of information to carry their employees with them at all times, but their employees must show equal evidence of a wish for co-operation. Too often the conference table is looked upon as a platform from which the men's leaders can declaim against the actions of management, and the popular conception is that management must stand for this.

Those who cry loudest about lack of joint consultation should ask themselves the following questions before they appear at the conference table:

(i) Do I fully understand the aims of management in the problems we are about to discuss?

(ii) What action will in the long run be of most benefit to our constituents and the community?

(iii) If this action is likely to present disadvantages to a few and future advantages to the many, how are we going to give the maximum help to the few who are displaced through no fault of their own?

(iv) Is an efficient company, making good profits, a good one to work for? And is it most likely to be able to provide security, good working conditions and good wages for its employees?

In a well-managed company it should be unnecessary to dismiss anyone on account of redundancy, for sufficient advance notice should enable normal labour turnover to absorb any excess. To achieve this needs the longest possible forewarning, and it needs men's representatives who are prepared to co-operate with management in ensuring the future prosperity of all, including anyone who is displaced and needs to transfer his now redundant services to other fields.

CORRESPONDENCE

SCIENCE FOR MODERN LIFE

From H. G. GANGE, GRADUATE

In 'Science for Modern Life' in the March *Journal* Dr. Bronowski proposes that atomic theory should be introduced at the beginning of the school course, and that 'the physical and chemical behaviour of matter should from the outset be shown consistently to flow from it'. But if our aim is to present to the child that which can be most directly experienced and to emphasize the living nature of science, is it not preferable to leave the more hypothetical aspect until a later stage?

The world of the atom is an unnatural world, in which the concepts of everyday life no longer apply. So far as we can directly perceive, matter always exhibits *qualities* of some sort, but in the atom we deal primarily with *numbers* representing mass, charge, velocity. The theory requires us to visualize, as best we can, that all which we experience as quality somehow arises from the activity of these purely quantitative atoms. This absence of quality in the atom is of our own making: it is inherent in the mathematical processes upon which the atomic theory is based. If we teach this theory to the child from the age of eleven we may well defeat our object of making science come to life for him.

ARS MARTIS COMES

From COLONEL M. O'C. HORGAN, O.B.E., T.D., M.SC., MEMBER

Many members must have read with interest in the *Journal* some of the history of the London Electrical Engineers, one of the oldest of the military volunteer units in the Kingdom, and one closely associated throughout its life with The Institution and its members. Many were probably dismayed to see, towards the end of the article, an inference that this honoured unit had now ceased to exist, and the ties so long maintained had been broken. I am happy to be able to assure them that this is not so: the statement recording the disappearance of 'The L.E.E. Unit founded by volunteers nearly sixty years ago' referred to one only of the several branches of the London Electrical Engineers.

An official document 'The Revised Title and Designations of Major Units of the Territorial Army—1951' makes it clear that, prior to the last war, the title 'London Electrical Engineers' was borne by both the 26th (London Electrical Engineers) Anti-Aircraft Battalion R.E. and the 27th (London Electrical Engineers) Anti-Aircraft Battalion R.E. When the Territorial Army was re-formed in 1947, the titles and traditions of the L.E.E. were vested by the War Office in those units being raised in the traditional locations of the L.E.E. Some of these units still exist and include the designation 'London Electrical Engineers' in their official titles.

The descendant of the 27th (L.E.E.) Anti-Aircraft Battalion R.E. is 'R' (London Electrical Engineers) Battery of 624 Light Anti-Aircraft Regiment R.A. (T.A.), located at 55 Mitcham Lane, London, S.W.16.

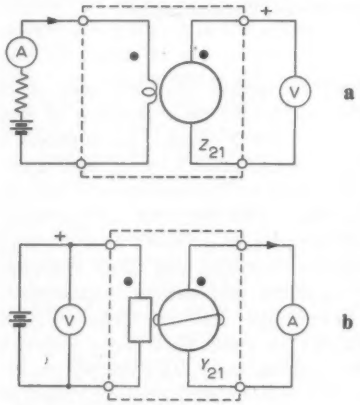
There is also a T.A. Unit descended from the 26th (L.E.E.) Anti-Aircraft Battalion R.E. (T.A.)—the 324 Field Squadron R.E. (London Electrical Engineers) T.A. The latter was resuscitated in 1947 at the old headquarters in Regency Street, Westminster, occupied by the original volunteers at the beginning of the century. It has since been moved to a modern Training Centre at 239 Uxbridge Road, Hammersmith, W.12, where it flourishes.

IDEAL ACTIVE ELEMENTS

From DAVID MORRIS, D.SC., ASSOCIATE MEMBER*

The current-voltage transactor, described by Mr. G. E. Sharpe in the January issue of the *Journal*, is an ideal current-operated voltage generator, as illustrated within the dotted lines of Fig. 1*a*, the defining parameter being the open-circuit transfer impedance Z. The dual element is an ideal voltage-operated current generator,[1] as illustrated within the dotted lines of Fig. 1*b*, the defining parameter being the short-circuit transfer admittance Y.

A dot notation is associated with the labelling of the elements of Fig. 1, and this may be used independently of the



1 *Ideal coupling elements*
a Current-operated voltage generator.
b Voltage-operated current generator.

sign conventions of the circuits in which the ideal generators are incorporated. If positive voltage is applied or current is injected at the dotted field terminal, a positive voltage or an emerging current appears at the dotted armature terminal. This is in conformity with the *cascade sign convention* which would be adopted for a practical generator, as shown in Fig. 2, in order that the actual currents and voltages should conform

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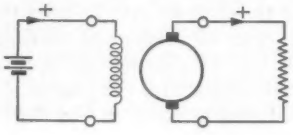
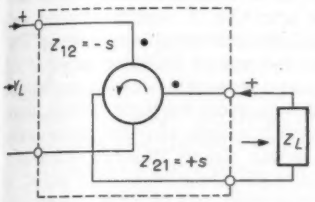


2 *Cascade sign convention*

in direction to the conventional currents and voltages, and thus be positive in sign.

In the cascade sign convention for a coupling network, the input terminal pair is governed by a *passive sign convention* in which the conventional current flows in a direction dictated by the conventional applied voltage; and the output terminal pair is governed by an *active sign convention*, in which the conventional current flows in a direction dictated by the conventional voltage derived from the coupling network. For some problems, particularly when networks involving many terminal pairs are involved, it is more convenient to adopt a *symmetrical sign convention*, in which the same convention (usually the passive) is adopted at all terminal pairs.

If a d.c. armature of negligible self-impedance, fitted with two pairs of brushes as shown in Fig. 3, is rotated in an



3 *Metadyne gyrator*

unwound smooth cylindrical stator, the relationships of the voltages to the currents may be expressed in terms of a rotational constant s, the equations, on the symmetrical sign convention, being:[2,3]

$$\begin{aligned} V_1 &= -sI_2 \\ V_2 &= sI_1 \end{aligned} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

These equations are of the same form as the equations (1) given by Mr. Sharpe. An impedance Z_L when viewed through the coupling network appears in admittance form as $Y_L' = Z_L/s^2$, corresponding to the well-known 'dualizing' aspect of such a machine. A convertor of this kind is in essence a passive device, because the smooth current-free stator cannot take any grip on the flux, and there is no energy exchange between the electrical and mechanical systems. In fact, the air-gap may be eliminated, and the iron of the magnetic return path may be made integral with that of the armature. Either the armature or the brush gear may then be rotated, as discussed in the 1882 and 1908 patents on the device.[4,5]

The equations of the *metadyne*, described above, also govern the *anti-reciprocal box*, described by E. M. McMillan,[6] and the *gyrator*, postulated by B. D. H. Tellegen.[7] The anti-reciprocal box is formed by mechanically coupling an electrostatic transducer to an electromagnetic transducer. McMillan has also described[8] other possible passive arrangements, including the use of the Hall effect. Devices based on the gyromagnetic effect[9] and the ferromagnetic Faraday effect[10] have also been described.

The description of passive devices with anti-reciprocal or gyrator properties is important on both theoretical and practical grounds. However, a representation in terms of active elements, as referred to by Mr. Sharpe, may be more convenient in some practical applications, for example in coupling two sections of an analogue having systems of representation that are mutually dual.[1] Fig. 4 illustrates two such gyrator circuits and these may readily be given counterparts in terms of electronic amplifiers.

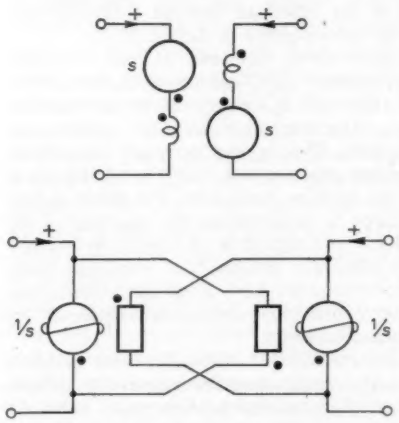
It is of interest and of practical significance to note that, since either of the passive elements in Fig. 3 of Mr. Sharpe's letter may be dualized by viewing it through a gyrator formed from either of the two active elements, not more than three of the elements are necessary.

P.S. Since submitting the above letter, I have read the communication on the same subject from Mr. A. W. Keen, as published in April, and note that he employs arrows to define the polarities of his voltages. It appears to me that this quite common practice can lead to difficulties.

The properties of linear coupling networks, whether ideal or practical, may be fully defined in terms of measurements made with suitable ammeters and voltmeters at the terminals. The ammeter determines a circuital direction for the current, which may properly be indicated by means of an arrow. The voltmeter determines that one terminal is relatively positive, and the other relatively negative, and the terminals may properly be so marked. Such markings have to be associated with correct signs and values for the four coefficients in the appropriate equations, or for the four labels on the circuit diagram.

It does not appear to be necessary to attribute circuital directions to the voltages, and any attempt to do so may lead to lack of unanimity in interpretation. No circuital direction may be obtained by measurement for the voltage at the two-terminal boundary between two networks permanently connected.

1 MORRIS, D.: 'Mechanical Networks', *Journal I.E.E.*, 1955, **1** (New series), p. 318. (See Fig. 2.)
2 FLETCHER, G. H., and TUSTIN, A.: 'The Metadyne, and its Application to Electric Traction', *Journal I.E.E.*, 1939, **85**, p. 370.
3 MORRIS, D.: 'An Investigation of Parasitic Brush Currents in Single-Phase Commutator Machines, with Particular Reference to the Repulsion Motor', *Proceedings I.E.E.*, Monograph No. 67 U, June 1953 (**100**, Part IV, p. 114). (See Section 3.2.)
4 British Patent No. 1211, 1882.
5 British Patent No. 9146, 1908.
6 MCMILLAN, E. M.: 'Violation of the Reciprocity Theorem in Linear Passive Electromechanical Systems', *Journal of the Acoustical Society of America*, 1946, **18**, p. 346. (See section IV, 2.)
7 TELLEGEN, B. D. H.: 'The Gyrator, a New Electric Network Element', *Philips Research Reports*, 1948, **3**, p. 81.
8 MCMILLAN, E. M.: 'Further Remarks on Reciprocity', *Journal of the Acoustical Society of America*, 1947, **19**, p. 922.
9 British Patent 645905, 1947/50.
10 HOGAN, C. L.: 'The Microwave Gyrator—the Ferromagnetic Faraday Effect at Microwave Frequencies and its Applications', *Bell System Technical Journal*, 1952, **31**, p. 1.



4 *Gyrator circuits*
a Series-derived gyrator. b Parallel-derived gyrator.

CORRESPONDENCE *(contd.)*

ALTERNATOR FIELD CURRENTS AND REACTANCES

From D. H. TOMPSETT, B.SC.(ENG.), ASSOCIATE MEMBER*

In two recently published books[1,2] comprehensive accounts are given of the symmetrical short-circuit of an alternator. Reference 2 includes the first published expression I have seen for the field current i'_f, which is superimposed under these conditions upon the steady-state field current i_{fL} or i_{fO}. (Expressions for i'_f are, however, given for unbalanced short-circuits in Reference 3.)

I had occasion to derive this same expression some time ago in connection with calculations on field circuit-breakers. The result, for a short-circuit from load conditions, which is mentioned, but not quoted, in Reference 2, becomes:

$$i'_f = i_{fL}\left(\frac{x_d - x'_d}{x'_d}\right)\left\{V_q\left[\varepsilon^{-t/T'_d} - \left(1 - \frac{T_{kd}}{T''_d}\right)\varepsilon^{-t/T''_d} - \frac{T_{kd}}{T''_d}\varepsilon^{-t/T_a}\cos\omega t\right] + V_d\frac{T_{kd}}{T''_d}\varepsilon^{-t/T_a}\sin\omega t\right\} \quad (1)$$

In eqn. (1) the notation of Reference 2 has been used, T_{kd} being the direct-axis damper leakage time-constant. It should be noted that an error has occurred in the definition of this term on p. 123 of Reference 2, its value being, in fact, $x_{kd}/\omega r_{kd}$, as given on p. 120 and p. 150.

For a short-circuit from rated open-circuit voltage, therefore:

$$i'_f = i_{fO}\left(\frac{x_d - x'_d}{x'_d}\right)\left[\varepsilon^{-t/T'_d} - \left(1 - \frac{T_{kd}}{T''_d}\right)\varepsilon^{-t/T''_d} - \frac{T_{kd}}{T''_d}\varepsilon^{-t/T_a}\cos\omega t\right] \quad (2)$$

I found that the term T_{kd}/T''_d, which defines the initial amplitudes of the alternating and the sub-transient components, could be expressed as the following function of the machine reactances:

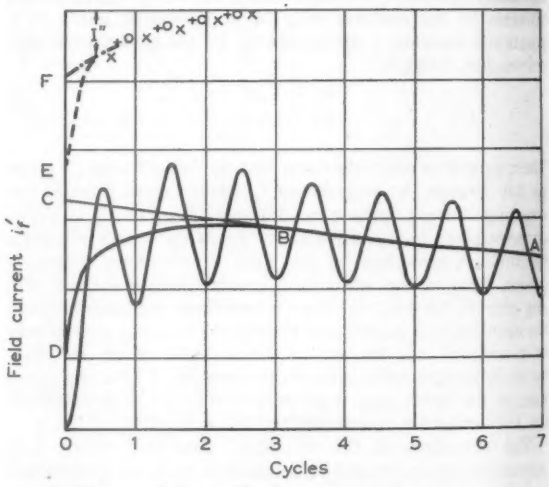
$$T_{kd}/T''_d = \frac{x'_d}{x''_d}\cdot\frac{x''_d - x_l}{x'_d - x_l} \quad . \quad . \quad . \quad . \quad (3)$$

In eqn. (3), x_l is the armature leakage reactance (the symbol x_a is used for this quantity in Reference 2).

The interesting point about this result is that, if a field current record is available, T_{kd}/T''_d can be evaluated from it, and, by using eqn. (3), with x'_d and x''_d calculated from the armature currents, a value can be arrived at for x_l, the armature leakage reactance. This is not normally considered capable of independent measurement, but it is an important component of all the machine reactances. The result quoted above enables a check to be made on the accuracy of the calculated value of x_l. This should be of interest to machine designers, because alternator ratings have increased many times, and significant changes have been introduced since publication of the expressions commonly employed for calculation of electrical constants.

An example of i'_f for a 75 MVA turbo-alternator is shown in the graph. The initial amplitude of the transient component is found by exponential extrapolation of the mean value AB back to the point C (i.e. the instant of short-circuit). Plots of field a.c. component and armature unidirectional components of current show consistent, and approximately constant, damping back to one half-cycle after the short-circuit, as illustrated also in Reference 1, p. 51. If the value of T_a, the armature time-constant, thus obtained is presumed to be valid back to the initial instant, a value can be given to the initial crest amplitude OD of the a.c. component in the field current. The point D then defines the start of the mean current as shown in the graph. In the example shown, the value of T_{kd}/T''_d (= OD/OC), is approximately 0·3, and the corresponding value of x_l is 0·092 per unit, using conventionally derived values for x'_d and x''_d. The sub-transient component is the intercept between CB and DB. It decreases very rapidly in the first half-cycle and thereafter decays with time-constant approximately equal to T''_d.

The points plotted in the upper part of the graph show, to a different scale, the amplitude of the sub-transient component I'' in each phase of the armature. A significant (and well-known) feature here is that the first useful measurement of I'' for any phase occurs at the second recorded peak of the current, since only then can a reasonably correct estimate be made of the other side of the current envelope. This is, therefore, always more than one half-cycle after the short-circuit, and so the presence of a very rapidly decaying component will not be observable from the armature-current record. In this respect the field-current trace may be more informative. Comparison of the two sub-transient components in the graph suggests that the armature current I'' should perhaps



Additional components of field current after short-circuit

be considered to start from a point E rather than F, where the conventional single exponential term might be thought to originate.

A change of flux linkage in damper bars, slot wedges and a solid rotor is well known to involve a multiplicity of decay terms; its analytical representation by means of a single additional rotor winding can be only approximate. Furthermore, the effects of saturated conditions before the short-circuit are normally neglected in theoretical approaches to the problem. Rüdenberg[4] gives an account of this aspect which shows that it leads to a result similar to that discussed above. Adkins[2] notes the discrepancy between the armature and

* Mr. Tompsett is with the English Electric Co.

field sub-transient components but appears to regard the former as the more reliable. This particular point depends partly upon whether one considers the assumption of constant value back to the initial instant to be more justifiable in the case of T_a or T''_d.

It should be remarked that the apparent underestimations of initial values of I'' are not of practical significance with respect to peak short-circuit currents and winding forces, or to circuit-breaker rupturing capacity. As the above discussion makes clear, the whole point is that any additional components decay so quickly that they will not be observable in the armature currents; therefore no necessity arises to question the utility of the conventionally derived values of x''_d and T''_d. However, it is questionable what is the appropriate value of x''_d to employ if eqn. (3) is to be used to estimate x_l. This is a matter which may profitably be given further attention.

1 KIMBARK, E. W.: 'Power System Stability, Volume III, Synchronous Machines' (Wiley, 1956).
2 ADKINS, B.: 'The General Theory of Electrical Machines' (Chapman and Hall, 1957).
3 CHING, Y. K., and ADKINS, B.: 'Transient Theory of Synchronous Generators under Unbalanced Conditions', *Proceedings I.E.E.*, Monograph No. 85 S, December 1953 (**101**, Part IV, p. 166).
4 RÜDENBERG, R.: 'Saturated Synchronous Machines under Transient Conditions in the Pole Axis', *Transactions of the American I.E.E.*, 1942, **61**, p. 297.

Training Britain's Engineers

From a speech by a headmaster at a Local Centre Dinner

This note on secondary education by the Rev. R. G. Lunt, Chief Master of King Edward's School, Birmingham, contains the substance of an address delivered by him at the Annual Dinner of the South Midland Centre of The Institution on the 1st February 1957.

OUR starting-point should be with figures: at the moment Britain compares unfavourably with her principal rivals in the recruitment and training of engineers (not only electrical, but of all sorts). The U.S.S.R. has 280 graduate engineers per million of her population, the United States has 130, Western Germany 86 and Switzerland 82. Below all these—although our university courses are often shorter—comes the United Kingdom with a score of 60. If our pyramid is thus narrow at its top, the height of skill and scientific knowledge, it is proportionately narrower than those of our competitors in the lesser, lower rungs of engineering qualifications.

My argument here is, in brief, that if we need to enlarge the top of the pyramid, we must first set about doing so by enlarging its base. The place where in this century most (but by no means all) our technologists have received their education has been the country's grammar schools, many of which started as a result of the Education Act of 1902. By the Act of 1944, places in these schools became available to very many more boys and girls, with the result that we have the curse of our day—the 11-plus selection examination, from which a large number of thoroughly good children are sent empty away. The public for the grammar schools has greatly increased, but there has not been a proportionate increase in the provision of grammar school places. Moreover, the chief source of professional engineers has been, and will continue to be, the grammar schools.

At this point it may be timely to try to give the *coup de grâce* to the old canard that grammar schools train people for black-coated, clerical, very nearly parasitic occupations. For years now a large proportion of grammar school boys have been entering at one level or another—16, 18, or after university—on a scientific future of some kind. They have: but there are not enough of them. Analyses by the Youth Employment Service of the City of Birmingham provided the following statistics for 1956. A total of 1751 grammar school children (aged 16) had seriously considered leaving school; of these, 997 were boys, and 421 boys decided after advice to continue for at least one further year at school, while 60 boys went on to full-time further education, a large proportion of whom were intending to study advanced science. Of 479 boys who left school to begin careers, 45% went into engineering or scientific jobs, 37% went to posts in local government, Civil Service, or insurance, or to clerical posts. The remaining 18% went into the Forces, police, farming, articled clerkships, printing, woodwork, or commercial art. It is quite untrue to suggest that grammar school headmasters have a vested interest in urging their pupils to take an arts course. In fact they have probably been awake to the country's need and this generation's opportunity rather longer than most other people. On the other hand they would not regard it as consonant with their professional honour to coerce children because of society's need into a course for which they were manifestly unsuited. It was suggested to me once some ten years ago that the problem confronting the schools was not a shortage of science teachers, but a glut of would-be science pupils who were not really up to it. This I do not regard as wholly true, although it may contain an element of truth. We simply must help these would-be technologists towards mastery of the admittedly difficult and intricate studies which their career and our economy demand.

There is no short-circuiting of the difficulties. For most people mathematics will have been at one stage or other difficult; however that must not be a reason for

abandoning the study. For the rising generation it will be more difficult still—and this not solely, nor even principally, because there is more of it, but because there is a really dangerous dearth of good young teachers of it. At present we are counting too much on the 'over-45's', and there are not enough getting ready to succeed them. The greatest thing that professional Institutions could do in this day of urgency would be to evolve a closer relation with the schools, not simply by careers propaganda, but by schemes of secondment of men who are qualified and would like for five years or so during their early career—say between 25 and 30—to do what is at once a very likeable and a very valuable piece of service. To be a teacher it is not necessary to become one for life. We need to ensure that there is a much closer give-and-take between the science of to-day and the science of the class-room.

If we are going to produce more people fitted for higher qualifications in technology—either through universities or through sandwich courses and technical colleges—we have got to broaden the basis of our selection field. The best way towards this is to increase the number of grammar schools. Throughout the country there is much hard feeling about selection at 11-plus. In this nobody has seriously suggested that the grammar schools are undesirable in themselves; the trouble is that they are too desirable. It is a case of too many parents chasing too few places. And the places are too few: in Birmingham the Education Committee is proud that it has managed in a time of growing population to keep the level of places at 15% of the total leaving primary schools, i.e. providing barely more than a 1 in 7 chance. If a grammar school takes in an entry of 100 boys, about 60 will leave at 16. As we have seen, nearly half of them will go towards industry, and there they will need to be taught their trade or profession; but it will be building on slender foundations. Some by force of personality and sheer 'guts' will rise. But I would trust more the chances of an average boy if he had more grounding. Of the 40 left, some 30 will go to some form of advanced science work; and these will be the potential recruits not only for engineering, but for industry generally—and for medicine, dentistry, teaching and the other professions that demand scientific training. In this day and age to be giving the chance to three-tenths of 15%, i.e. 4½%, of an age group, is of course quite ludicrous. Something must be done, and done quickly.

Technical schools are designed to come to the rescue, and they are to be welcomed; but I do not like the name, or the suggestion that at the age of 11 a serious career choice can be made. Human beings are not the raw material for a conveyer belt, and it just does not work to place an order for *x*-thousand technicians or technologists in *y* years' time, and then dragoon people into the production line. Technical colleges are excellent—at last we seem to be getting under way with them; but there can be little doubt that they will be able to do their best work with the ex-grammar-school boy.

For the work we have in hand, if we are to meet the requirements of our society, three things are necessary—in this order:

(i) The services of first-class men and first-class minds, not just what can be spared, but men on whom it is desired that budding recruits should model themselves. Now there are not many of these about, and it is mistaken policy to distribute them thinly but evenly over the ground. It is better to set up schools where they can be used to the full on profitable work.

(ii) A school that is a community, i.e. one that is large enough for boys to know people doing quite different studies from themselves, and small enough for every member to count as one and to have a good and fair chance of experiencing success. Throughout this article I have been writing about the training of the ordinary man to become a highly skilled and reliable technologist. The genius will reach the top whatever we do, but the ordinary mortal needs the influence of the right environment to become his best self.

(iii) Premises which do lend themselves to decent, serious and fairly high-grade practical work. These are very expensive and must therefore be responsibly used, with a good prospect of a reasonable return on society's investment.

There exist to-day some ugly fashions of thought, chiefly from across the Atlantic, to the effect that education can be all fun and purged of the old-fashioned note of sustained serious endeavour, that all men are born equal and that therefore the same sort of schooling is the right schooling for all, whatever their gifts. But even the United States has lost faith during this century in its high schools: it would be an unwise moment for us to try an experiment, proved unsuccessful over there, in a Britain poised so precariously as we are on the edge of an economic precipice. We need to go about the task of survival the hard way, the proved way, and to extend to larger numbers the opportunities associated with the grammar school. This is not to say grammar schools are perfect: very far from it. For instance we are in danger of excessively narrow specialization in our sixth forms; we do too much teaching by word of mouth, making too little time for heuristic method and placing too little premium on intellectual adventure and initiative. But in the grammar schools we have a priceless heritage, where mathematics and physics can be taught to a high standard, while the boy is not allowed exclusively to concentrate on them; where he has some opportunity of learning citizenship; and where he has high standards of keenness and industry ever before him. Such schools, it is plain, need to be made more widely available. It might seem regrettable as a further invasion of the sphere of local government, but it would be welcomed as just, if the Minister of Education were to direct all local authorities to provide, as a minimum, grammar-school places to a level of 25% of the numbers leaving primary schools. In this 25% there might well prove to be an element of wastage, but I am confident that the additional number of 'late developers' picked up would very amply compensate for this. Only if there were throughout the country this provision would it then be tolerable in any political party to 'look at' the public schools, which are—*pace* some of the doctrinaires of the Left—doing something to ease the situation created by the shortage of grammar-school places.

SHORT REVIEWS OF PAPERS

On the following pages are some brief review articles based on, and written by the authors of, current Institution papers. The authors have been asked to make these articles, so far as possible, interesting and of appeal to electrical engineers who have no specialized knowledge of the subjects, and the content of the articles is not necessarily confined to the subject-matter of the original papers.

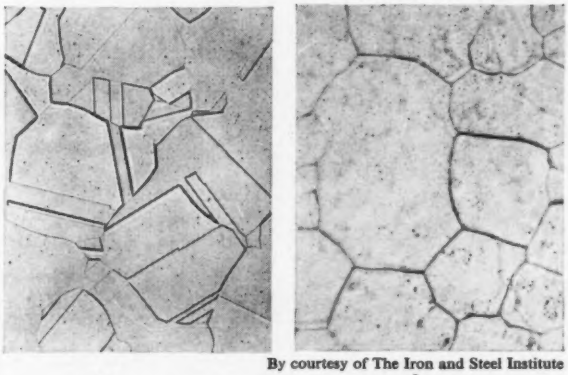
High-Permeability Nickel–Iron

A short review of a Measurement and Control Section paper (No. 2136) entitled 'An Experimental Study of High-Permeability Nickel–Iron Alloys', by C. E. Richards, F.R.I.C., E. V. Walker, B.Sc., and A. C. Lynch, M.A., B.Sc. The paper was published individually in August 1956, and it will be republished in Part B of the Proceedings. The authors are at the Post Office Engineering Research Station.

THE INITIAL PERMEABILITY OF ORDINARY IRON IS A FEW hundred, but that of nickel–iron alloys easily reaches a few thousand. Of these alloys, those in a certain small range of compositions (containing about 75 to 80% nickel) can be made to have initial permeabilities of over 20000, or, with special heat-treatment, over 100000. Confusion has been caused in the past, however, by the quoting of optimistic values, such as 30000 for alloys which, when made on a commercial scale and subjected to factory handling, sometimes had a permeability as low as 5000; and there has undoubtedly been an extravagant use of good material because cautious designers have worked with this low figure to allow for the occasional batch of poor material. The maximum permeabilities of these materials are usually about four times the initial values.

The materials are used mainly in transformer cores for communication circuits, in the cores of current transformers, and in the cores of magnetic amplifiers. A possible future use is in storage circuits. For these purposes the alloys are used in the form of laminations or coils of insulated strip, and are often very thin. From the point of view of handling the material, the lower limits are usually regarded as about 0·004 inch for laminations and about 0·000 6 inch for wound strip, but for some purposes thinner material would be welcome. The cost of manufacturing such thin materials is mainly that of rolling them; the cost of the raw material is unimportant in comparison.

A study of nickel–iron alloys has been made during the past nine years, with the main object of finding the reasons for the wide differences between the properties of apparently similar materials. An important tool in this study was the use of powder metallurgy for making small quantities of experimental alloys: in this process metal powders are mixed, pressed, and then sintered at a temperature of the order of 1 300° C; at this temperature they alloy by diffusing into each other. A small block of material made in this way can be rolled into strip just like a cast ingot. The strip is not porous, and under casual observation looks like that made in the normal way, but metallographic examination shows that it contains fewer inclusions. This can be seen by comparing Fig. 1(*a*) and Fig. 2(*a*).



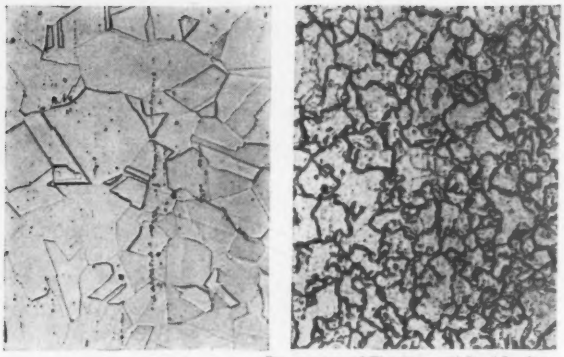
By courtesy of The Iron and Steel Institute

a b

1 *Microstructure of alloy made by powder metallurgy and annealed in wet hydrogen*
a Interior. b Surface. Magnification ×200.

The main result of this work was to show that the dependence of the initial permeability on the composition is so critical that the permissible limits of composition may be difficult to achieve consistently by conventional melting processes, as demonstrated in Fig. 3.

A further result was to show the importance, when annealing strip made by conventional methods, of using a protective atmosphere of extraordinary dryness (having a dew-point below −50° C); this precaution need not be observed, however, with materials made by powder metallurgy. This is the only advantage which alloys made by powder metallurgy have over the better batches of melted alloys. Water vapour in the annealing atmosphere reacts with any silicon which may be present in the alloy, forming silica. This prevents the formation of large crystals at the surface of the metal, and the resulting surface layer of small metal crystals has been shown to



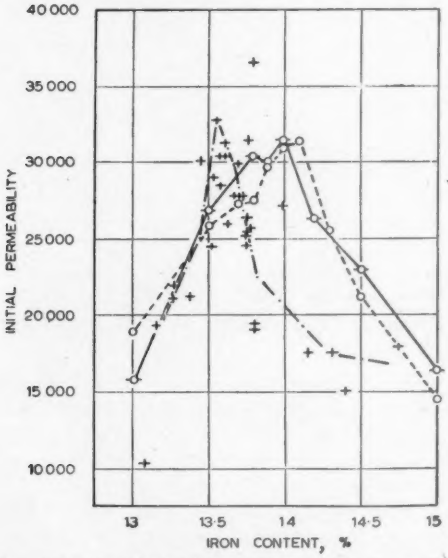
By courtesy of The Iron and Steel Institute

a b

2 *Microstructure of alloy made by melting and annealed in wet hydrogen*

a Interior. b Surface. Magnification ×200.

have low permeability. The existence of this layer can be shown by comparing the surface structure after annealing in wet hydrogen with that revealed after the surface layer has been removed by chemical polishing. This is illustrated in Fig. 2. On the other hand when this treatment is



3 *Variation of initial permeability with composition*

—·— + Commercial alloys.

——○} Powder-metallurgy alloys from two sources.

– – –○}

given to powder-metallurgy strip, crystal size at the surface and in the bulk of the metal is found to be the same, as shown in Fig. 1.

There has been a general belief that strip less than about 0·002 inch thick necessarily has a low permeability. This has been found to be untrue; it is possible to produce strip 0·0003 inch thick having a permeability of 30 000, by attention to the purity of both the alloy and the annealing gas. On the other hand, these very thin strips always have losses several times as great as would be expected from their resistivities; this anomalous loss varies with thickness, and in 0·0003-inch strip it is about five times the ordinary eddy-current loss.

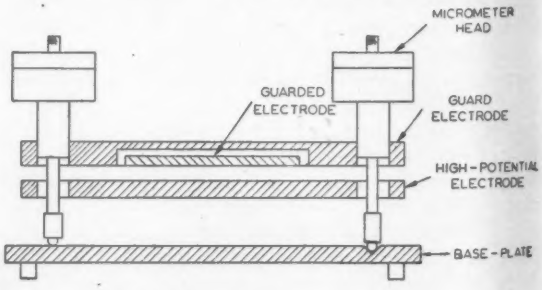
The authors are now hoping to find out, in collaboration with manufacturers, what standard of properties can be consistently obtained by melting processes, and meanwhile to encourage the use of powder metallurgy on a commercial scale as an alternative method of manufacture which yields alloys of consistent performance. 621.318.1

Permittivity Measurement

A short review of a Measurement and Control Section paper (No. 2208) entitled 'A Method for the Precise Measurement of Permittivity of Sheet Specimens', by A. C. Lynch, M.A., B.Sc. The paper was published individually in October 1956, and it will be republished in Part B of the Proceedings. The author is at the Post Office Research Station.

THE ACCURACY WITH WHICH PERMITTIVITY CAN BE measured is limited almost entirely by the difficulty of measuring the thickness of the specimen, which is usually chosen to be only one or two millimetres for the sake of providing a capacitance large enough to be easily measured. Increased precision can be achieved by using a thicker specimen, even though its capacitance may then become less than 10 $\mu\mu$F.

This argument led to the development of the electrode system of which the drawing shows a cross-section. The separation of the electrodes is controlled by the three micrometer heads on which the upper electrode stands.



Cross-section of the apparatus

The diagram is not drawn to scale, and for simplicity the supports for the electrodes have been omitted from the diagram.

The specimen is inserted loosely between the electrodes, resting on the lower one, and the capacitance of the

system is measured. The specimen is then removed and the separation reduced until the capacitance is the same as before. The permittivity can then be calculated as the ratio of two lengths, independent of any electrical units.

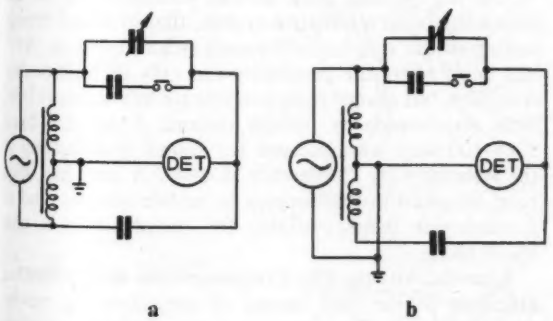
Fortunately the apparatus is very quick to use, especially for testing a series of nearly similar specimens, since there is no question of applying electrodes to each specimen. The measurement of the thickness of the specimen is still the biggest source of error, but with a specimen $\frac{1}{4}$ inch thick the error is only about 1 part in 1 000.

Although the apparatus was not originally intended for the measurement of power factor, it can be used for this purpose with fair accuracy. Its sensitivity is less than that of other methods, because of the air-gap whose capacitance is in series with that of the specimen, but on the other hand there can be no uncertainty about whether the electrodes are in satisfactory contact with the specimen. 621.317.335

Capacitance Measurement

A short review of a Measurement and Control Section paper (No. 2209) entitled 'A Bridge Network for the Precise Measurement of Direct Capacitance', by A. C. Lynch, M.A., B.Sc. The paper was published individually in October 1956, and it will be republished in Part B of the Proceedings. The author is at the Post Office Research Station.

IF A CAPACITOR OF LESS THAN ABOUT 100 $\mu\mu$F CAPACITANCE is to be measured with reasonable precision, it must be regarded as having direct capacitance between its terminals and also stray capacitances between each terminal and the surroundings; the surroundings are usually treated as earthed. The problem is to arrange that neither of the stray capacitances influences the measurement. A circuit commonly used for the purpose is a Schering bridge with a Wagner earth connection, but the simultaneous balancing of the main and Wagner-earth networks is tedious. A convenient substitute is a network, sometimes called a *transformer bridge*, in which the ratio arms are coupled by mutual inductance, as in part (*a*) of the diagram. Here one of the stray capacitances appears across the detector, where it is harmless; the other is across half of the transformer winding, and if the coupling between the two halves of the winding is perfect, capacitance across the one half cannot affect the balance of the bridge.



a b

Transformer bridges

a The established form of transformer bridge.

b A modified bridge in which stray capacitance does not affect the balance.

In these diagrams, for simplicity, the means of balancing loss components have been omitted.

It is good practice to work by substitution—that is, to make balances with and without the specimen connected, so that its capacitance is given by the change in a variable capacitance connected in parallel with it. Both these circuits were originally designed for balancing without substitution, however, and if a limitation to substitution methods is accepted it is possible to improve on them. Part (*b*) of the diagram shows a modified transformer bridge, in which the stray capacitances fall across either the oscillator or detector and are completely harmless even though the transformer is imperfect. The circuit can be used at any frequency for which a satisfactory transformer can be made, and it can measure capacitances of any size, large or small, for which a standard is available for substitution. Its advantages appear especially in the measurement of capacitances of less than about 100 $\mu\mu$F, which are often accompanied by stray capacitances comparable with, or greater than, the direct capacitance to be measured. In practice the immunity to errors is such that a stray capacitance of 1 000 $\mu\mu$F changes the balance by less than 0·001 $\mu\mu$F. 621.317.335.2

Transformer Bridge

A short review of a Measurement and Control Section paper (No. 2247) entitled 'A Simple Transformer Bridge for the Measurement of Transistor Characteristics', by W. F. Lovering, M.Sc., Associate Member, and D. B. Britten, B.E., Graduate. The paper was published individually in December 1956, and it will be republished in Part B of the Proceedings. The authors were formerly at the New South Wales University of Technology, Australia. Mr. Lovering is now at Imperial College, London, and Mr. Britten is now in the Postmaster General's Department, New South Wales.

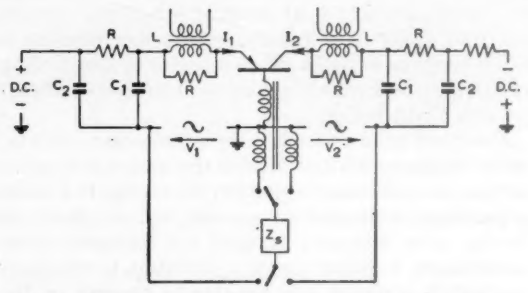
THE PAPER DESCRIBES THE APPLICATION OF A BRIDGE WITH inductively coupled ratio arms to the measurement of the impedance parameters of point-contact or junction transistors.

The impedance parameters of a three-terminal network are specified by:

$$V_1 = I_1 Z_{11} + I_2 Z_{12}$$
$$V_2 = I_2 Z_{22} + I_1 Z_{21}$$

where V_1 and V_2 are the potential differences between two pairs of terminals and I_1 and I_2 are the corresponding currents.

The circuit is connected as illustrated in Fig. 1. The



1 *Bridge with current-detection circuits and d.c. biasing*

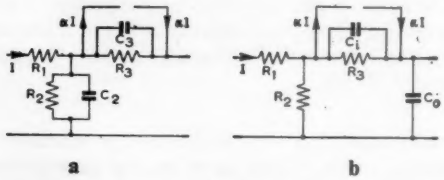
transformer in the emitter circuit and that in the collector circuit serve to detect the presence of an alternating current. Each current-detection circuit is made to approximate to a pure resistance R by the addition of the two resistances $R = \sqrt{(L/C_1)}$ and capacitances C_1 and C_2, where $C_2 \gg C_1$. The ratio transformer has a Permalloy ring core with toroidal windings giving ratios of 1 : 10 or 10 : 1.

If V_1 is adjusted in phase and magnitude to make I_1 zero, and Z_s is connected to V_1 (or Z^s to V_2) and adjusted for zero voltage across the ratio transformer, then

$$V_1 = I_2 Z_{12}$$
$$V_2 = I_2 (Z_{22} + R)$$

whilst $V_1/Z_s = I_2/T$ (or $V_2/Z'_s = I_2/T$), where T is the transformer turns ratio. Z_{12} and Z_{22} can thus be measured in terms of Z_s and the transformer ratio. Similarly if V_1 is adjusted to make I_2 zero, Z_{11} and Z_{21} can be measured. A complete set of parameters can be measured with a precision of better than 1% in less than five minutes.

The impedance parameters of a junction transistor, in the common-base connection, have unexpectedly large values of capacitance associated with Z_{11} and Z_{12}, but



2 *Alternative equivalent circuits of a junction transistor with emitter current of 3 mA*

$R_1 = 30$ ohms $R_2 = 280$ ohms $R_3 = 1{\cdot}7$ megohms $\alpha = 0{\cdot}95$
$C_2 = 0{\cdot}058$ pF $C_3 = 36$ pF $C_0 = 21$ pF $C_i = 15$ pF

it is shown that these may be accounted for by a small capacitance in the collector circuit. Alternative equivalent circuits having identical impedance parameters are illustrated in Fig. 2. The bridge circuit may be modified to measure directly the components of the circuit of Fig. 2(*b*).

The bridge is used to measure the parameters of transistors connected in the common-base circuit. A simple rearrangement of connections would enable it to be used with transistors connected in the common-emitter arrangement.

621.317.733.029.3 : 621.314.7

V.H.F. Broadcasting

A short review of a Radio and Telecommunication Section paper (No. 2258) entitled 'The B.B.C. Sound Broadcasting Service on Very High Frequencies', by E. W. Hayes, Member, and H. Page, M.Sc., Member. The paper was published individually in November 1956, and it is republished this month in Part B of the Proceedings. The authors are with the British Broadcasting Corporation.

UNTIL RECENTLY THE B.B.C. SOUND PROGRAMMES INTENDED for reception in this country have been broadcast only on low- and medium-frequency channels. During the last twenty years the number of European stations working in these bands has been steadily growing; there has been an increase of more than 50% since 1950. As a result, insufficient channels are available to the B.B.C. for national coverage of the three sound programmes. Moreover, British stations are subject to interference from Continental stations working on the same channels. In addition, it has become necessary to restrict the bandwidth of receivers to avoid adjacent-channel interference, and the quality of reception available to the listener has deteriorated correspondingly.

The B.B.C. first gave serious consideration to the possibility of an alternative system, that of sound broadcasting in the very-high-frequency (v.h.f.) band, in 1945; this band offers the possibility not only of high-quality reception, but also of reception free (or substantially free) from interference by foreign stations. Later, the band 87·5–100 Mc/s was reserved for sound broadcasting at the Atlantic City Conference in 1947. A part has since been allocated in this country to mobile services, and as a result the band available for broadcasting is now 88–95 Mc/s.

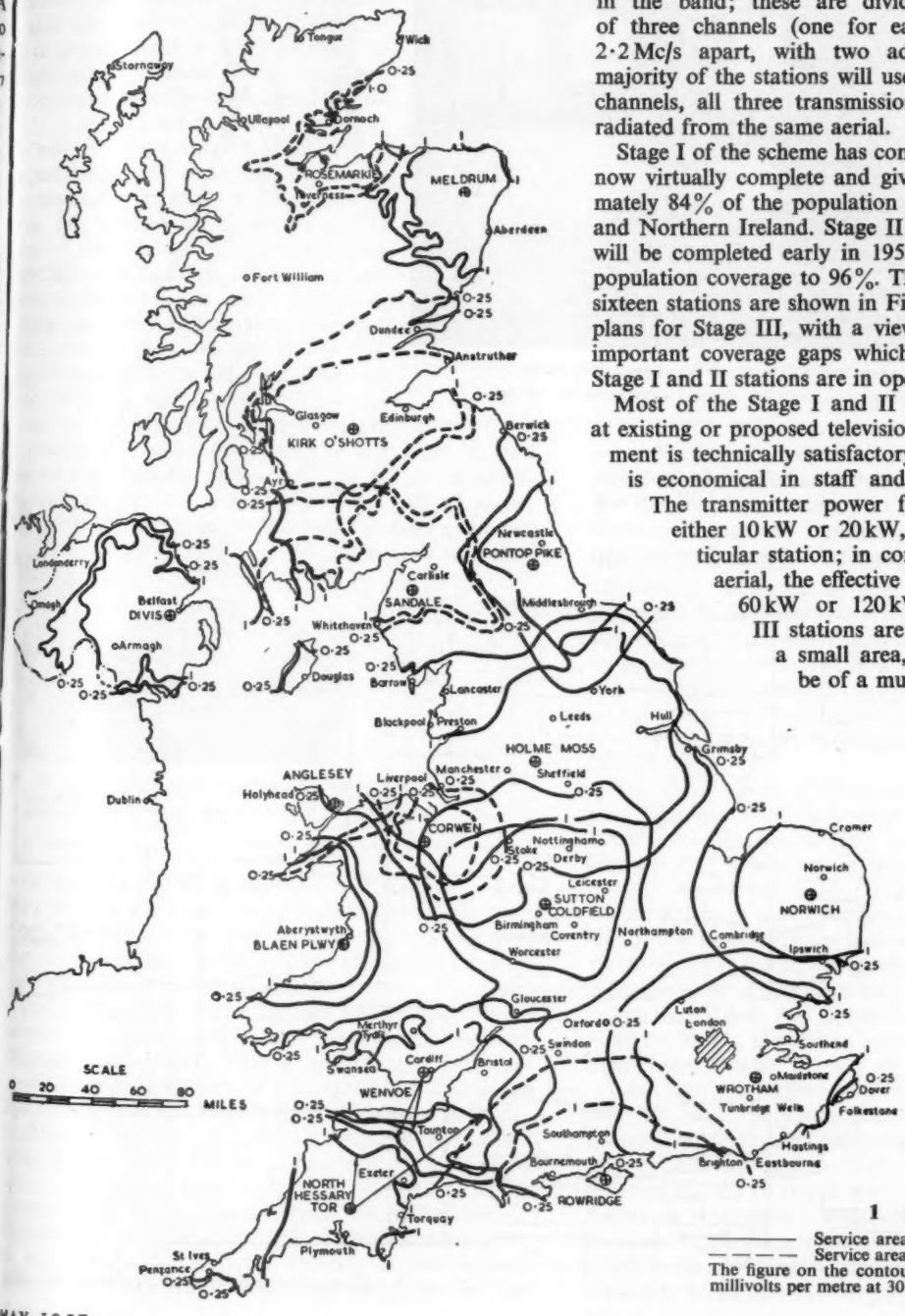
After the Atlantic City Conference, the B.B.C. directed attention to the best means of exploiting the newly-allocated band. Theoretical and experimental investigations of propagation conditions were carried out; different systems of modulation were also studied both in the laboratory and by field trials. One conclusion was that frequency modulation should be used for the new service rather than amplitude modulation—the system used in

the low- and medium-frequency bands. This was found desirable in order to offset the less advantageous propagation characteristics of the v.h.f. band, to make the most economical use of the frequency spectrum, and to minimize the total cost. In common with other countries broadcasting on v.h.f. using the frequency-modulation system, it was proposed to use a peak frequency deviation of ±75 kc/s and a channel spacing of 200 kc/s. These proposals were eventually approved by the Postmaster General, and preparations for their implementation began in 1954.

The plan will provide substantially complete national coverage of the Home, Light and Third Programmes. A total of thirty-five channels can be accommodated in the band; these are divided into eleven groups of three channels (one for each programme) spaced 2·2 Mc/s apart, with two additional channels. The majority of the stations will use one of these groups of channels, all three transmissions being combined and radiated from the same aerial.

Stage I of the scheme has comprised ten stations; it is now virtually complete and gives coverage to approximately 84% of the population of the United Kingdom and Northern Ireland. Stage II will add six stations; it will be completed early in 1958, and will increase the population coverage to 96%. The service areas of these sixteen stations are shown in Fig. 1. There are tentative plans for Stage III, with a view to filling in the more important coverage gaps which will remain when the Stage I and II stations are in operation.

Most of the Stage I and II stations will be located at existing or proposed television stations; this arrangement is technically satisfactory, and at the same time is economical in staff and building requirements. The transmitter power for each programme is either 10 kW or 20 kW, depending on the particular station; in conjunction with an 8-tier aerial, the effective radiated power is either 60 kW or 120 kW. Most of the Stage III stations are required to cover only a small area, and will consequently be of a much lower power.



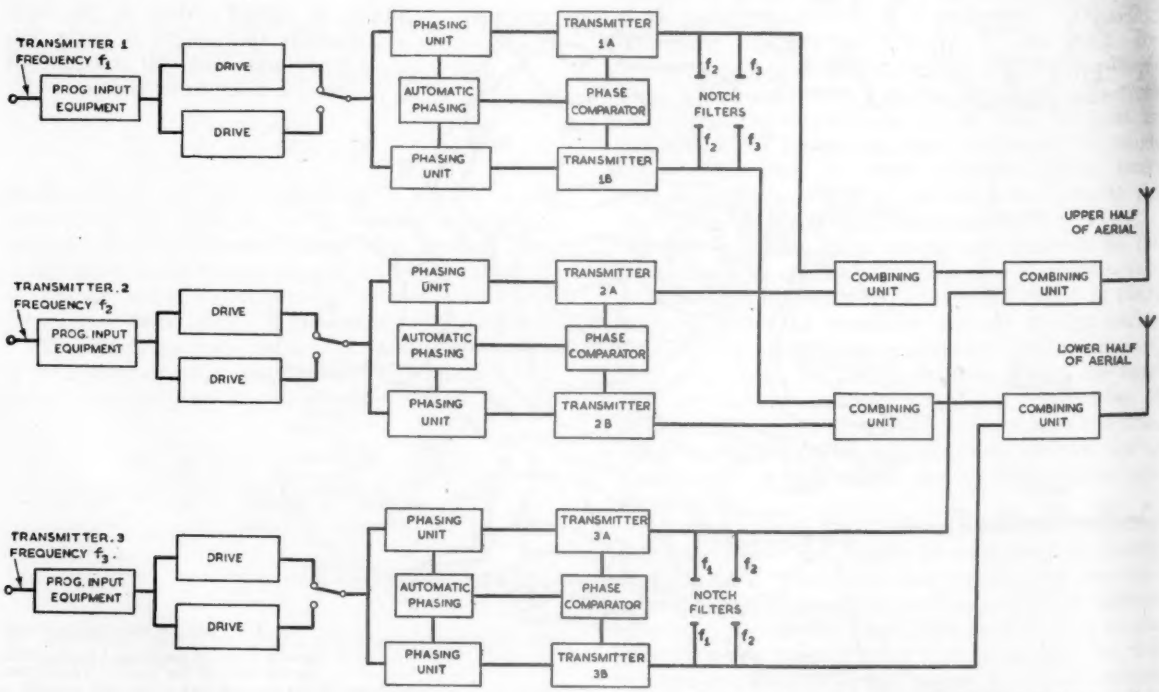
1 *Plan for national coverage*

———— Service areas of the Stage I transmitters.
– – – – Service areas of the Stage II transmitters.
The figure on the contour line is the field strength in millivolts per metre at 30 ft above ground level.

2 *Automatic monitoring, fault indication and programme input equipment*
In the background the drives and automatic phasing equipment can be seen.

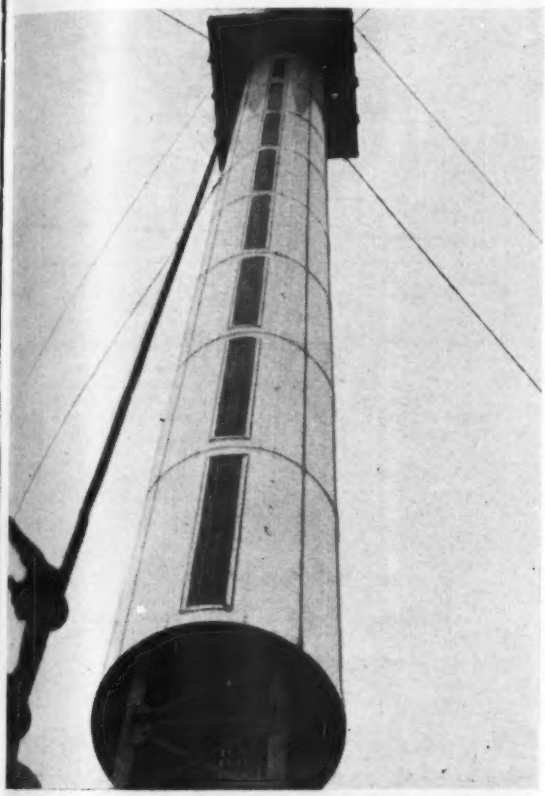
Two important requirements have dictated the planning of the transmitting equipment. It will operate unattended, although at the majority of stations television staff will be available in case of emergency. The equipment starts up and closes down automatically. Comprehensive fault indication and automatic monitoring arrangements are installed in the transmitter hall; a photograph of this equipment is shown in Fig. 2. An engineer who has been summoned by an alarm is able to ascertain at once from the indications which part of the transmitter chain is faulty. Only the low-power stations will be unattended in the strict sense; in the event of a fault leading to a break in transmission a carrier alarm will be operated to call a part-time member of staff living in the vicinity.

The second requirement is that of maximum reliability. The salient feature is the use of duplicate transmitting chains, working in parallel, for each programme. The aerial also is split into two halves, each half being fed from a separate feeder. Three transmitters (one for each programme) form one group, and the combined output is connected to one half of the aerial system through its own feeder; the other group of three transmitters is connected to the other half of the aerial system. The general arrangement is illustrated in Fig. 3. The signals radiated from the two halves of the aerial are arranged to be in phase; if there is a fault in either half of the system the other half continues to radiate.



3 *General arrangement at 3-transmitter station*

The transmitting aerial takes the form of vertical slots cut in a cylinder, which encloses the column of the steel support mast; a photograph is shown in Fig. 4. Each of the eight tiers comprises four slots equally spaced round the periphery of the cylinder. The earlier aerials were made of galvanized steel, but more recently an aluminium



4 *The 8-tier aerial which radiates the three programmes*
Each tier comprises 4 vertical slots cut in a cylinder.

aerial has been used, made for the B.B.C. by a firm specializing in the manufacture of air-frames. This latter type is hoisted into position in sections, each complete with its distribution feeder and a back screen to cover the steel frame of the mast.

The success of the service depends on the design of the receiver to a much greater extent than does its medium-frequency counterpart. There are many difficulties associated with the design of v.h.f. receivers, and in the light of these difficulties the British models have, generally speaking, a satisfactory performance. However, one design aspect merits further attention. Most multi-band sets (i.e. combined medium-frequency/f.m. sets) incorporate a ratio detector rather than the earlier type of detector—i.e. a phase discriminator associated with one or more limiters. The ratio detector is not entirely effective in suppressing amplitude variations of the received signal. As a result distortion may occur in conditions of severe multi-path propagation—when delayed signals are received in addition to the direct signal. Under these conditions more effective limiting is required than that provided by the ratio detector.

About 500 000 v.h.f. sets are now in use in the United Kingdom, and a steady increase in this number is expected as the coverage is extended. Many other countries are developing v.h.f. services at the present time. It was expected that about 600 v.h.f. transmitters would be in use in Europe by the end of 1956.

621.396.712 : 621.376.3

The B.B.C.'s V.H.F. Service

A short review of a Radio and Telecommunication Section paper (No. 2267) entitled 'Frequency-Modulated V.H.F. Transmitter Technique with particular reference to the B.B.C. United Kingdom Service', by A. C. Beck, B.Sc.(Eng.), Associate Member, F. T. Norbury, Associate Member, and J. L. Storr-Best, B.Sc.(Eng.), Associate Member. The paper was published individually in November 1956, and it is republished this month in Part B of the Proceedings. The authors are with Standard Telephones and Cables Ltd.

THE SOUND BROADCASTING SERVICE OF THE B.B.C. IS BEING considerably extended by the rapid introduction of a network of frequency-modulated v.h.f. transmitters operating in the 88–100 Mc/s band. A number are already in operation, and by the end of 1957 some thirty-two high-power transmitters, together with a large number of equipments of lower power, will be in regular operation, giving improved reception to all areas in the United Kingdom.

The introduction of the system of frequency modulation, together with the change to a higher frequency, necessitates the use of new receivers and marks the beginning of a new era of sound broadcasting in this country. By the use of three transmitters of equal power, spaced 2·2 Mc/s apart, radiating from one aerial at each site, it will be possible for listeners in all areas to receive the three main B.B.C. programmes at equal levels, with the same high performance and quiet background.

The paper describes equipment specially designed to meet the B.B.C.'s stringent requirements for their main high-power stations.

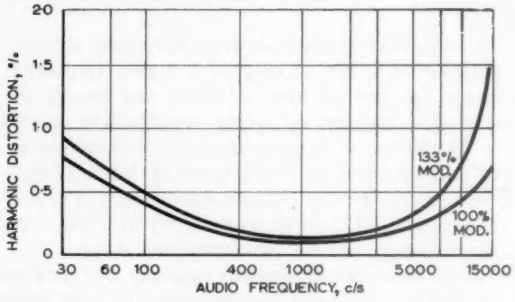
Each site is equipped with three 10 kW transmitters, one for each programme, the three outputs at the different carrier frequencies being combined in a suitable filter circuit and fed to a single wide-band horizontally-polarized aerial. In the interests of continuity of service the whole equipment is duplicated, including the aerial. In normal operation both sets of equipment work in parallel, necessitating a phasing control which automatically keeps the two aerial currents in phase. As

virtually no coupling exists between the two aerials, independent switching of any transmitter of either group is possible, a feature which simplifies control, permits daytime maintenance, and makes unattended operation possible.

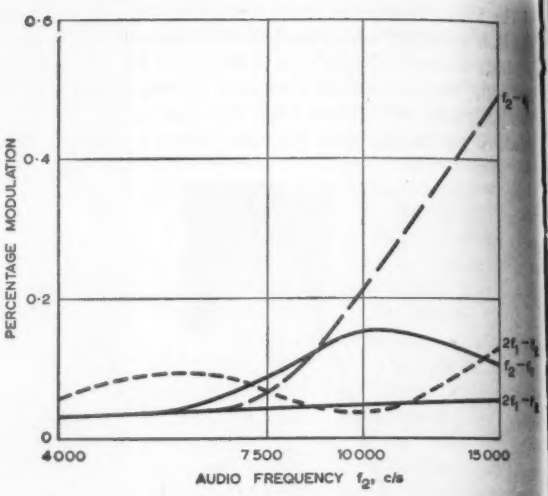
The 10 kW transmitter consists basically of an f.m. drive unit, in which the carrier is generated and frequency modulated by the programme input. The modulated output of the carrier is 5 watts. The drive unit is followed by a four-stage amplifier—the first two stages using tetrodes and the last two using triodes in grounded-grid circuits. In parallel operation of the transmitters only one f.m. driver can be used; the other is kept continuously working and is automatically switched into operation if the quality from the drive unit in use has deteriorated.

The system of frequency modulation uses a free-running valve oscillator working on a frequency of approximately 5 Mc/s and modulated by a reactance modulator. The modulated carrier is frequency-multiplied and amplified to a level of 5 watts. To ensure the required stability for the carrier centre frequency, a radio-frequency divider chain is used. This divides the modulated output by 500 and thus reduces the modulation index. The effect of this is virtually to eliminate the sidebands, thus enabling a comparison to be made with a temperature-controlled crystal oscillator. Any difference frequency arising is imparted to a special motor which automatically corrects the centre frequency by operating a trimming condenser on the free-running oscillator unit.

The performance possible with frequency modulation is superior to that possible with amplitude modulation, and extremely low values of distortion and intermodulation products are consistently maintained, as shown in Figs. 1 and 2.



1 *Audio-frequency distortion of the drive equipment*

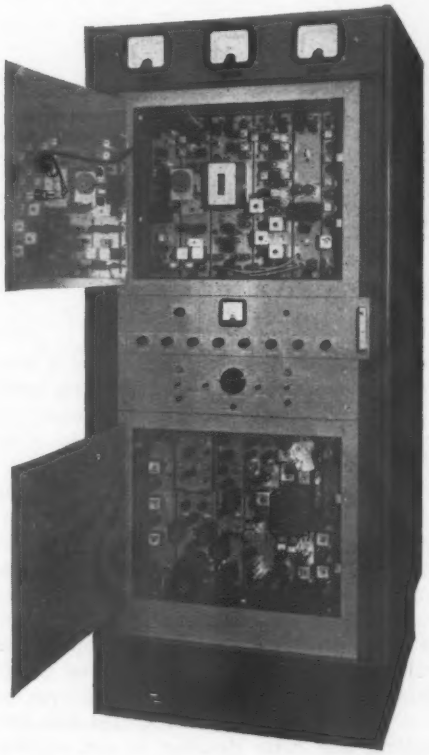


2 *Audio-intermodulation products of the drive equipment*

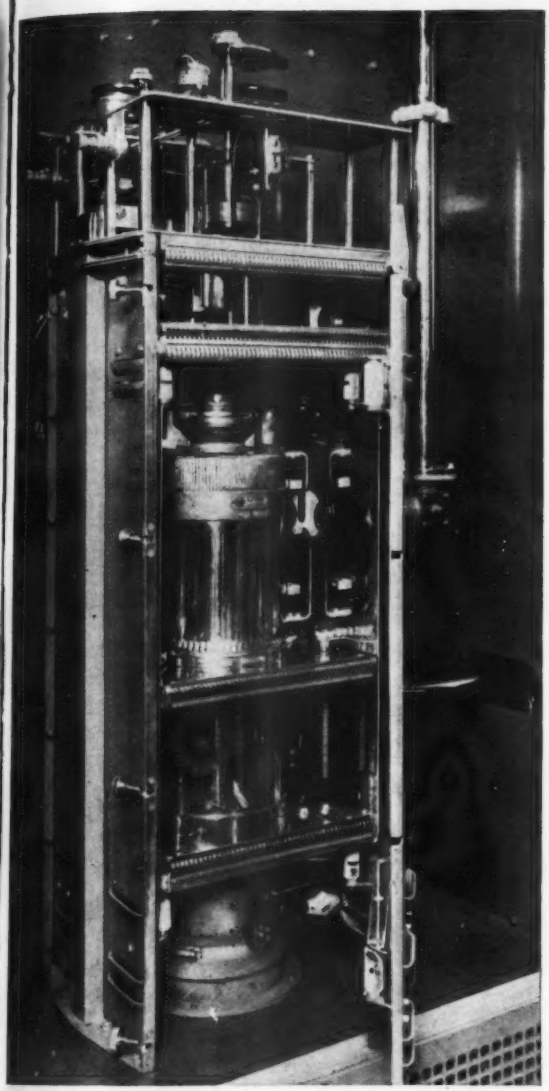
f_1 and f_2 are the frequencies of two sound carriers, such that $f_2-f_1 = 75$ c/s. Full lines show carriers modulated to 50% by each frequency. Broken lines show carriers modulated to 66% by each frequency.

The type of construction of the low-power driver stages follows the unit principle, with vertically mounted chassis readily detachable for servicing and testing. Fig. 3 shows the main units of the drive equipment.

The amplifiers, including their power supplies, are contained in three cabinets, the radio-frequency section



3 *F.M. drive equipment*

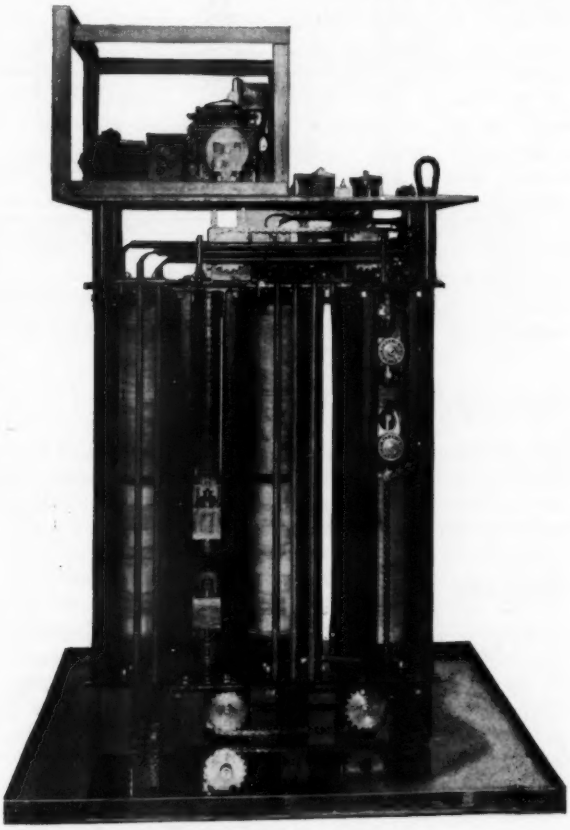


4 *Final-stage amplifier unit*

of the final 10 kW stage being shown in Fig. 4. The radio-frequency 'cavity' is of box sections, and a door gives access to the air-blast-cooled thoriated-tungsten-filament valve, which, owing to its weight, is placed in position by means of a hand-operated jacking system. The tuning of the circuits is performed by motor-operated rotating loops in the grid and anode circuits.

Cooling air for the valve anode is derived from a blower and filter mounted in the cabinet directly below the valve. The warmer discharged air can be recirculated in the transmitter hall in the interests of economy. The earlier stages of the amplifier are of similar construction.

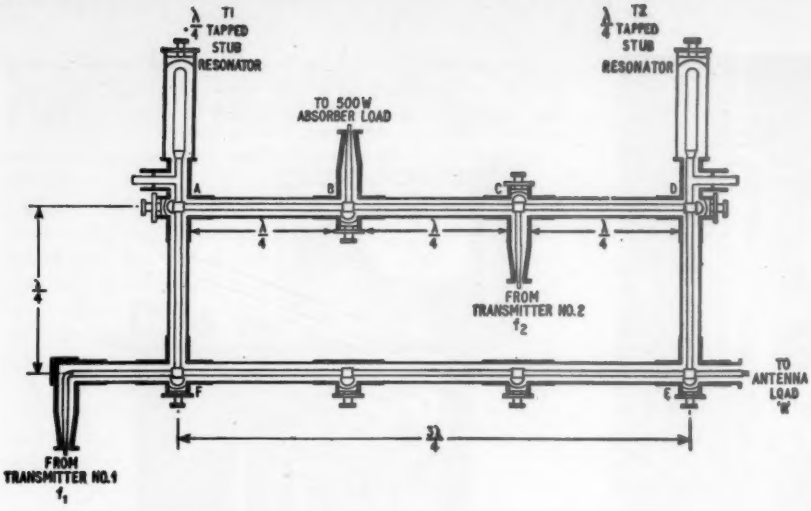
For the purpose of unattended operation, the transmitter control circuits have been simplified in the extreme by the introduction of a new type of voltage regulator, the internal construction of which is shown in Fig. 5.



5 *Internal view of regulator*

With this regulator the mains voltage is applied slowly to the transmitter, starting at zero and rising to full voltage over a period of 30 sec. This voltage is applied simultaneously to the blower, filaments and h.v. anode supplies. This avoids the need for contactors or other more conventional forms of sequential starting. On attaining full voltage the regulator functions as a normal regulator, maintaining the a.c. output voltage to within $\pm 1\%$. On overload, or switching off, the circuit of the magnetic clutch of the voltage-raising circuit is broken, and the regulator automatically returns to zero.

The combination of three 10 kW transmitters, using a common aerial and operating on different frequencies with different programmes, constituted a difficult design problem because of the necessity for keeping to a low order any cross-modulation which, at these power levels, would cause interference with other radio services. The problem was solved by the use of a new type of filter combining circuit, known as the *bridge ring filter*, which is of simple construction and is shown diagrammatically



in Fig. 6. The filter is made of single coaxial copper transmission line to which is added two identical frequency-sensitive circuits, tuned to the operating frequencies. The coupling between transmitters with this system is very small.

The complete transmitter, including the voltage regulator and f.m. drive unit, occupies little floor space and has an overall conversion efficiency of the order of 46%. 621.396.712 : 621.376.3

6 *Circuit of bridge-ring filter*

SYNOPSES OF PAPERS

The following are synopses of papers published in the *Proceedings* which have not been read at an Institution meeting and which have not been described under 'Short Reviews of Papers'. They are included here primarily for reference. The papers have not been published individually, as have those for reading at meetings, but reprints of them will be available shortly.

Oversea V.H.F. Propagation

A synopsis of a Radio and Telecommunication Section paper (No. 2345) entitled 'Long-Distance Propagation at 94·35 Mc/s over the North Sea', by R. W. Rowden, B.Sc.(Eng.), Member, and J. W. Stark. The paper is published this month in Part B of the Proceedings. The authors are in the B.B.C. Research Department.

A SERIES OF V.H.F. MEASUREMENTS OVER LONG SEA PATHS was made over a period of 15 months. The results suggest that, in general, higher field strengths are reached for a given percentage of the overall time than is the case for overland paths. 621.396.11.029.62

Thermionic Rheostat

A synopsis of a Measurement and Control Section paper (No. 2288) entitled 'A Thermionic Rheostat for Automatic Control', by E. G. Hopkins, Ph.D., B.E. The paper was published in April 1957 in Part A of the Proceedings. The author is at the School of Electrical Engineering, New South Wales University of Technology, Australia.

THE PAPER DESCRIBES AN EXPERIMENTAL THERMIONIC rheostat in which the spacing between the two thermionic cathodes is controlled by rotating the valve, while one cathode is held stationary by means of an external permanent magnet. The tube is sealed into a small receiving-valve envelope and will control a.c. loads of up to 60 watts when operated as a series resistor from 240-volt mains. Three experimental closed-loop automatic-control systems are described whose electrical circuits consist simply of experimental valves actuated by mechanical error signals and controlling the current delivered to a.c. motors: the systems are a position control, a velocity-integral control for moving materials and an air-flow control. 621.385.16 : 621.316.824

Hybrid Microwave Junctions

A synopsis of a Radio and Telecommunication Section paper (No. 2356) entitled 'A New Form of Hybrid Junction for Microwave Frequencies', by P. D. Lomer, M.Sc., A.Inst.P., and J. W. Crompton, B.E., Associate Member. The paper is published this month in Part B of the Proceedings. Mr. Lomer is at the Services Electronics Research Laboratory. Mr. Crompton is at the Chemical and Physical Research Laboratory, South Australia, and was formerly at the Radar Research Establishment.

THE PRINCIPLE OF THE BRANCH-WAVEGUIDE DIRECTIONAL coupler has been applied to the design of a new form of hybrid junction for microwave frequencies. An equal division of power between the main and subsidiary waveguides is achieved by arranging the voltage coupling coefficients of the branch-waveguides in accordance with the coefficients in a binomial expansion.

Details of design and performance of such a hybrid junction are given for the 3 cm waveband. Its properties are superior to those of the hybrid-T and rat-race and compare favourably with those of the short-slot hybrid. In addition, the geometrical configuration of this form of hybrid junction is convenient for the construction of compact waveguide circuits. 621.372.832.6

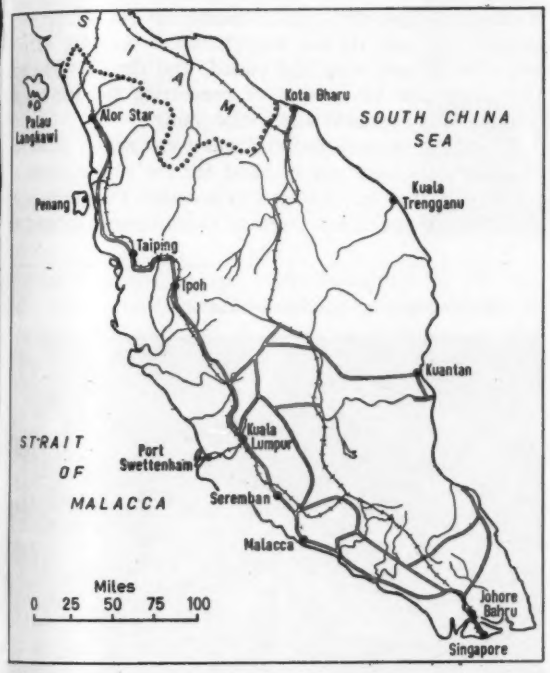
PRESENTING THE FARADAY LECTURE IN MALAYA

The 26th Faraday Lecture, entitled 'Courier to Carrier in Communications', by Mr. T. B. D. Terroni, found eager audiences in a distant Commonwealth country as in the United Kingdom. It was thought that, in view of the approaching independence of Malaya and Singapore and the consequent desire to staff the public services with Malayan engineers, local delivery of the Faraday Lecture would stimulate recruitment into the electrical engineering profession. Principle, however, proved easier than practice, and this article describes the many difficulties which had to be overcome before the author's successful presentation of the lecture in the leading towns. Mr. Smith is with the Malayan Telecommunications Department.

DENNIS SMITH, ASSOCIATE MEMBER

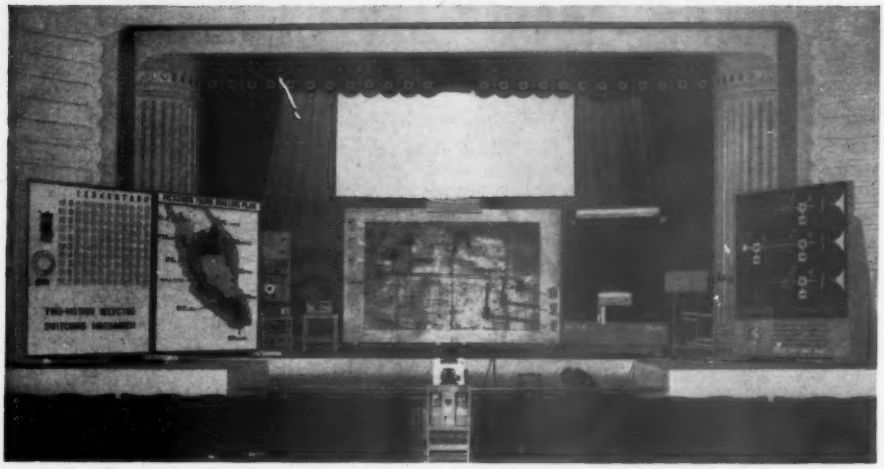
MICHAEL FARADAY'S great work was largely carried out during the first half of the nineteenth century, the period in which Singapore was established by Raffles. Although the other British settlements at Penang and Malacca were already in existence at that time, British influence was not effective in the Malay States until the second half of the century. Towns such as Kuala Lumpur, Ipoh, Taiping and Seremban where the lecture was presented, were not built until well after Michael Faraday had died.

The 1954–55 Faraday Lecture was concerned with communication, and the Honorary Secretary of the Malaya and Singapore Oversea Committee, Mr. W. Trafford, thought that it would be possible for an officer of the Telecommunications Department, with the assistance of the Department, to present the lecture in Malaya. The Oversea Representative of the Council, Mr. J. Sharples, pursued this matter and obtained the Council's approval, in principle, of the project. He suggested that an officer of the Malayan Telecommunications Department should attend the lecture whilst on leave in the United Kingdom and judge whether it would be practicable, with the lecturer's consent, to present it in Malaya. The manufacture of duplicate demonstration models would be within the capacity of the workshops of the Telecommunications Department and of the Central Electricity Board of Malaya. Readers may judge the size of these organizations by the fact that the Telecommunications Department at the end of 1956 maintained 57 358 telephone stations, and the generating capacity of the Central Electricity Board at the end of 1956 was 136 MW, both in an area of approximately 51 000 square miles. Because I was to be on leave in the United Kingdom during the lecture period and for long enough afterwards to make the necessary arrangements for its presentation in Malaya, I was asked by the Oversea Representative in Malaya to take on this task. Whilst on leave I attended the lecture three times, and although rather worried by the complexity of some of the apparatus and the very high standard of workmanship, I was assured of such generous assistance from the lecturer, Mr. T. B. D. Terroni, and his and other organizations, that I recommended to those concerned in Malaya that we should proceed with the project.



Malaya, showing principal towns and road and rail communications

There was a special reason for trying to present the Faraday Lecture in Malaya. Both the territories of the Federation of Malaya and Singapore are approaching independence, and the declared intention of the two Governments to 'Malayanize' the public services as soon as possible will mean a considerable exodus of expatriate chartered engineers, and it is imperative to attract recruits to electrical engineering. Further, a very considerable development of the economic resources of Malaya is planned, and this will result in a large expansion of communications and electricity supplies, increasing the need for engineering staff. The life and work of Michael Faraday, who achieved so very much from such humble beginnings, would indeed be an inspiration for Malayans.



The stage at Kuala Lumpur, set for presentation of the lecture

I returned to Malaya in June 1955 with all the information and specialized equipment which Mr. Terroni and his organization were able to give or lend. This included a 6-inch magnetic drum, copies of both the films used in the lecture, and a tape recording of the music used in the lecture.

We could not use the magnetic drum for storage of information as in the original lecture, because of the very real possibility of disturbing the magnetization during the long journey to Malaya and the difficulty we should have, with our relatively limited facilities, in rectifying this. Mr. Terroni's staff therefore designed suitable relay sets for 'memory' storage, which, with minor circuit changes, worked very well in practice.

Manufacture of the items was divided between the workshop of the Telecommunications Department and that of the Central Electricity Board, each doing the work most appropriate to its resources. This was a very large additional load on the workshops, especially since duplication of the original items elsewhere had not, of course, been envisaged during manufacture; the three-channel model, for instance, had been developed in a 'model room' atmosphere, and detailed drawings of the final items were not always available, so that it was necessary to work from photographs and do quite a lot of development work ourselves. This, of course, meant a great deal of additional work for our already overworked staff, particularly the supervising engineers who had most of the work to do. Thus it took about ten months to manufacture, assemble, and test the various items.

An example of some of the practical difficulties was that the fluorescent paints used in the United Kingdom for the three-channel exhibit, when applied to the 'ping-pong' balls here, could not be induced to dry satisfactorily in this climate. Fortunately one of the supervising engineers thought of using talcum powder to overcome the stickiness of the paint.

The construction of the demonstration items cost Government time and money, and it was necessary to get [9]Ministerial approval. Since many of the items were suitable for use in the Departmental training school when the lecture tour had ended, and the Government recognized the advantages of presenting the lecture in Malaya, this approval was forthcoming.

When the demonstration items were nearly finished, arrangements were put in hand for the presentation of the lecture at as many towns as possible. Committees of members of the Joint Oversea Group were formed in

The author delivering the Faraday Lecture

each likely town, to investigate suitable halls and solicit local support. Since the majority of the audience would be school-children, discussions were held with the education authorities, who were enthusiastic and promised every possible assistance. It was not always possible to find a suitable hall in each town, and even when halls were available it was always necessary to augment the platform. The lecture could not be given on the east coast of Malaya, at places such as Kuantan, because there were no public halls or school halls, and it

The reward for the effort

Keen interest is shown by the audience at Taiping.

was too expensive to hire cinema halls. Our lecture timetable had to be arranged to avoid clashing with school examinations, and the halls were sometimes so small that the lecture had to be repeated many times. Thus in Kuala Lumpur it was presented twice a day, in the afternoon and evening, on three successive days. The hall in Kuala Lumpur was air-conditioned, but only during performances, so that the equipment passed through several cycles of temperature and humidity; this may well have contributed to the minor equipment troubles we experienced there.

The formation of a lecture team presented some difficulty because engineers and technicians could not be easily spared by the two organizations, which were both short of staff. It was therefore necessary to arrange the lecture to fit in not only with the availability of halls, but also with public holidays and the need to avoid prolonged absences of senior staff from their headquarters.

Mr. L. A. Summerland, of the Telecommunications Department, and Mr. B. Cooper, of the Central Electricity Board, were principally responsible for the manufacture of the demonstration models, and together with a few of their technicians they formed the lecture team which assisted me so admirably in the presentation of the lecture.

Transport consisted of a three-ton lorry and trailer, a Land Rover and private cars. Because of the poor condition of a few of the roads, particularly over deviations necessitated by low bridges, etc., the models were bolted to the floor of the lorry and the trailer. We could not take the lorry and trailer, loaded, to Penang Island because of the low height in the ferry loading dock, and all equipment had to be unpacked and packed again at each side of the two-mile channel separating Penang from the mainland. We used to load the equipment at each centre at the close of the lecture, thus enabling the lorry to travel through the night to the next centre. However, this procedure was sometimes affected by the need to traverse curfew areas, and special arrangements at the Customs point between Singapore and the Federation were required. The lorry and trailer made an unscheduled diversion between Malacca and Seremban which took them into a curfew area, where it was stopped by the local police. Only prompt action secured its release to enable the lecture to be presented in Seremban on time.

A major problem was the difficulty experienced in darkening the lecture halls for the afternoon shows (sunset is about 7 p.m. all the year round in Malaya), while still retaining adequate ventilation for the large audiences.

It was very difficult to calculate the actual cost of presenting the lecture in Malaya, but the known charges for materials, transport, travelling and labour totalled £3 200, of which £200 was a grant from The Institution towards such charges as the hire of lecture halls.

The Institution film *The Inquiring Mind* became available during the lecture series, and it was shown at the end of the lecture. Although it made the lecture rather long for young audiences, it proved very popular.

We considered the possibility of making a film of the complete lecture, but it was decided that a 'live' presentation was essential, and our experience confirmed that this was a wise decision.

The lecture was given twenty times altogether, in Ipoh, Taiping, Penang, Singapore, Malacca, Seremban and Kuala Lumpur. The total audience, consisting very largely of school-children, was approximately 8 000, and we feel that the venture was a success.

OBITUARY

HERBERT BUCHANAN HARVEY

By the death of Herbert Buchanan Harvey on the 8th January 1957 at Eastbourne the electricity supply industry has lost one of its earliest managers. He was 84 years of age.

Educated at Aysgarth School, Yorkshire, at Westminster, and in Germany, he began his career as a pupil at the works of C. A. Parsons and Co., at Newcastle upon Tyne. Here he was fortunate in assisting in the construction of steam turbines, and was present at the trials of the s.s. *Turbinia*.

Wishing to become an electrical engineer, he joined the staff of the Newcastle and District Electric Supply Co. in 1898. Three years later he was appointed Manager and Engineer of the Cambridge Electric Supply Co., and in 1909 he moved to Rochester to take a similar position in the Kent Electric Power Co. After a few years he was elected a director of this company. Under Mr. Harvey's management, from 1909 to his retirement in 1935, the Kent Co. developed from a small lighting concern serving Rochester and Chatham to a large power company supplying an area of some 600 sq. miles. Supplies were made available not only to many Kent towns and villages, but also to a number of industries on the banks of the Rivers Medway and Thames, including the cement industry, which is a feature of the area.

Mr. Harvey served for some years on the then No. 9 Home Counties Joint Industrial Council for the Electricity Supply Industry, on the Provincial Electricity Supply Committee, and many other committees connected with the development of electricity supply. All who knew him were impressed by his knowledge of the industry, especially legal aspects of it.

He was a keen motorist, and enjoyed a game of bowls. His hobby lay in the workshop, where he was particularly outstanding in wood and metal work. For forty years he lived in Rochester, and was a member and Past-President of the Rochester Rotary Club.

After his retirement he moved to Eastbourne, and, although over 80 years of age, was present at the British Electrical Power Convention held there in 1954, enjoying his full faculties, and retaining his interest in the industry. He is survived by his wife and two daughters.

Mr. Harvey joined The Institution as an Associate in 1899 and was elected an Associate Member in 1901 and a Member in 1909.

H. F. K.; A. T. G.

JOHN ANDREW LEE

John Andrew Lee, O.B.E., who died on the 9th November 1956, was born in London on the 23rd November 1883. With other well-known figures in the electrical industry, he was educated at Bancroft's School, Woodford, and later attended evening classes at East London College. He began his engineering career in 1902 as a pupil of the late Mr. Arthur Shaw at Ilford electricity works. Four years later he was appointed Engineer-in-Charge at the generating station of Stepney Borough Council. In 1913 he joined Messrs. Ashwell and Nesbit as Assistant Engineer.

On the outbreak of the First World War he took, for him, the natural step of joining the Royal Engineers and served with them in the Middle East, where he took part in Allenby's drive to Jerusalem and Damascus.

On demobilization, he became Personal Assistant to Sir John Snell, and, when the latter became Chairman of the newly formed Electricity Commission in 1920, he joined the Commission's engineering staff. The Central Electricity Board was formed in 1927, and Lee transferred to it in July 1928 as Headquarters Construction Engineer for the Grid. His common-sense reactions to the many problems that arose during the intensive drive to keep to programme, his gift for friendship with all his fellow-workers and, not least, his knowledge of the mind and workings of the Civil Service, played no mean part in the success of the Board.

On the 1st April 1948, when the Central Electricity Board ceased to exist, he became Transmission Engineer of the new British Electricity Authority, retiring from this position in February 1949. Idleness in retirement had no attractions and, shortly afterwards, he joined British Insulated Callender's Construction Co. as Transmission Consultant, later becoming adviser on 132kV transmission lines to the Uganda Electricity Board.

In his professional life, Lee had the good fortune to find an outlet for his great abilities in the pioneering work of the Electricity Commission and the Central Electricity Board. He shared with many other friends their satisfaction in success. His later work in Uganda again enabled him to use his ripe experience in a pioneering venture of a very different nature—in which he again found happiness. The tragic death of his father in a railway accident when he was still a boy deepened his natural independence of thought and consideration for others.

His services to the electrical industry were recognized by his appointment as an O.B.E. in 1949. But it is in the memories of his friends that his place is secure. The picture of the lanky, watchful figure behind the wicket remains with them as a reminder of a firm friend in time of trouble, always ready to play the game, and completely selfless in his help to anyone in need. It is good to have known him.

He joined The Institution as an Associate Member in 1919 and was elected a Member in 1925. He served as a Member of Council 1946–48, a Member of the Transmission (later Supply) Section Committee 1940–3, Vice-Chairman of this Committee 1945–6, and Chairman 1946–7. He was also an Associate Member of The Institution of Mechanical Engineers.

J. D. P.

WYATT MEACHER

Wyatt Meacher, who died on the 2nd February 1957, was born on the 12th December 1872. He was one of the earliest students of Faraday House, beginning there in 1891, and after a period of power supply experience at the Deptford station of the London Electricity Supply Corporation and on the staff of Ferranti Ltd. at Charterhouse Square, he became in 1896 a founder of the Westminster Engineering Co. Six years later, while he was serving as a joint managing director of the company, its first factory was built at North Acton. For the last sixty years of his life Mr. Meacher was continuously associated with this electrical and mechanical manufacturing company.

A staunch churchman, Mr. Meacher was very happily married, and, although his tastes were simple, he had a wide variety of interests. Having been in his younger days a keen yachtsman, he enjoyed most outdoor activities, and for many years his chief hobby was gardening. He had too a well-equipped workshop at his home, where he spent many hours trying out original ideas and making various useful gadgets and implements; in fact, he was a practical engineer rather than a theorist.

He remained at work and was extraordinarily active right up to his last brief illness, and he retained his lively interest in scientific subjects. Widely respected for his upright character, he was also greatly liked for his unassuming kindliness, and will be missed by all who knew him. He leaves a widow, a daughter, and a son who is an Associate Member of The Institution.

Mr. Meacher joined The Institution as a Student in 1892 and was elected an Associate in 1895 and a Member in 1905.

H. D. H. F.; R. B. F.

LEONARD ERNEST MOLD

Leonard Ernest Mold, O.B.E., who was born at Oxford on the 16th April 1889, passed away on the 10th January 1957 after a short illness and was cremated at Newcastle upon Tyne on the 14th January 1957. He received his technical education at the Oxford City Technical School, and this was followed by four years' pupilage

with the Oxford Electric Light Co. After this he joined the Newcastle upon Tyne Electric Supply Co. as a junior engineer, where he gained valuable experience in the operation of generating plant and distribution equipment.

In 1912 he was appointed by the late Mr. H. W. Clothier of Reyrolle and Co. as a sales engineer, in which capacity he was one of the pioneers in the introduction of metalclad switchgear and was responsible for the early installations at major power stations such as those at Sheffield (Neepsend) and Birmingham.

He enlisted in the Royal Engineers in September 1914, rose to the rank of Major and was appointed Deputy Director of Army Signals. He was one of the first to be appointed an O.B.E. in the military division, and on four occasions was mentioned in dispatches. He was gassed at Ypres and later buried as a result of shell fire, and these experiences undoubtedly affected his health later in life.

After the war he returned to Reyrolle and Co., and subsequently went for a short time to the British Thomson-Houston Co. in Rugby. He rejoined Reyrolle in 1922, and was appointed Sales Manager in 1929 and a Director in 1937. He retired in 1954 at the age of 65. He was also a Director of C. A. Parsons and Co., the British Short-Circuit Testing Co. and J. H. Holmes and Co.

A member of the Council of the British Electrical and Allied Manufacturers' Association for many years, Mr. Mold played a prominent part in the development of the electrical industry, particularly in the field of switch and control gear for industrial purposes and supply systems, both at home and oversea.

He took an active part in the work of The Institution, as his record, given below, indicates.

All who knew Leonard Mold will pay tribute to his kindly nature and patience, and to his interest in helping younger engineers. Typical of his many attributes was his unbounded loyalty to his chief, the late H. W. Clothier, with whom for many years he was associated in pioneering modern techniques of switchgear construction.

Mold was well known on the tennis court and the golf course; he was an excellent host, especially in his own home with his beloved wife May, who survives him, together with their son and their daughter.

With such memories fresh in our minds, we, his friends, pay tribute to a good engineer, a good sportsman and a good friend.

He joined The Institution as an Associate Member in 1919 and was elected a Member in 1934. He was Chairman of the Newcastle Student Section 1912–13, a member of the North-Eastern Centre Committee 1927–1930 and 1935–1940, Vice-Chairman of this Committee 1932–33 and 1933–34, and Chairman 1934–35. B. H. L.

FRANK NELDER RENDELL-BAKER

Frank Nelder Rendell-Baker, who died on the 15th December 1956, was born in Bolton on the 2nd December 1886. He attended the local grammar school and received early technical education at the Bolton Technical School. After serving an apprenticeship with the Bolton electricity undertaking, he began his career with the King's Lynn Borough Council, and later worked for the Darwen and Farnworth electricity undertakings. He was appointed as shift engineer to the St. Helens municipal electricity undertaking in 1913, and after ten years became Engineer and Manager. He was appointed Chief Electrical Engineer to the Halifax Borough Council in 1928.

In May 1931 he became Chief Engineer and General Manager of the Croydon Corporation undertaking, where he remained until his retirement in March 1948. Between those years the yearly output of electrical energy from the undertaking increased from 49 842 to 147 596 MWh and the number of consumers connected from 30 443 to 69 170. During 1932 he was responsible for one of the earlier installations of sodium street lighting, the fittings being centrally suspended in Purley Way, Croydon. He was also responsible for the building of a large central office and showroom which was completed just before the outbreak of the Second World War.

In May 1939 Mr. Rendell-Baker prepared a scheme for the Croydon Corporation for the construction of a new generating station, designed for an ultimate capacity of 300 MW, but, because of the outbreak of war, the work was not begun on the station until 1945. In 1941, in addition to his normal duties, Mr. Rendell-Baker was engaged as consulting engineer for the mechanical and electrical engineering sides of this station. It was put into commercial use in September 1950 under the operation of the South Eastern Division of the Central Electricity Authority.

Although Mr. Rendell-Baker retired in March 1948, his services were retained by the Central Electricity Authority as a consultant until the end of 1950. During this time he also acted as consultant to the Croydon Corporation on street lighting and other electrical matters, continuing with this work until December 1955.

With the move of his home from Croydon to Hove, Mr. Rendell-Baker began a new chapter in public life, for in 1951 he was elected to the Hove Borough Council, serving successively as vice-chairman and chairman of several committees of the Council. He later became one of Hove's representatives on the East Sussex County Council and was Chairman of the Wish Ward of the Hove and Portslade Conservative Association. He was an enthusiastic gardener and was interested in sacred and classical music. Although he lived in the South of England for many years, he retained his membership as a Freemason of the Tranquillity Lodge in Liverpool.

He leaves a widow, who is a former Chairman of the National Executive Committee of the Electrical Association for Women, and a son.

Mr. Rendell-Baker was a man with forceful personality and great intellectual ability. He joined The Institution as an Associate Member in 1919 and was elected a Member in 1935. T. A. D. H.

RICHARD ALBERT WEAVER

Richard Albert Weaver, O.B.E., who died on the 26th January 1957, was born on the 14th December 1874. He was educated at the King Edward VI Grammar School, Birmingham, and was one of the many Post Office engineers of the early part of the century who came into engineering via the Telegraph Service, which he entered in Birmingham in 1890. While there he studied telephone engineering at Birmingham Technical College. He was transferred to the Engineering Department some three years later, and after some district engineering work at St. Albans and Dublin, he was successful in a competitive examination for promotion to Staff Engineer, Second Class (Assistant Staff Engineer), in the Engineer-in-Chief's Office.

He had, however, a strong predilection for district work, and in 1912 was transferred at his own request to the post of Assistant Superintending Engineer in London. In 1927 he was promoted to the position of Superintending Engineer of the North Wales District and held this position until his retirement at the end of 1934. He was appointed an O.B.E. in 1935.

Mr. Weaver thus served for 44 years in the Post Office during a time of very rapid development. He was concerned in the construction of the first Birmingham–London air-spaced lead-covered cable —the first of its kind to be laid in this country. In the latter part of his career, he was closely associated with the introduction of automatic telephone exchanges in London and elsewhere, and he supervised at Paisley one of the earliest automatic installations in the country. He was, therefore, well equipped to take the responsibility for beginning the transfer of the Birmingham director area to automatic working, which fell to him in the North Wales District.

In private life, Mr. Weaver was interested in the theatre and music but his favourite pastime was undoubtedly golf. On his retirement, he went to Parkstone, Dorset, and built himself a house within 200 yards of the local golf course, and it was not long before he was acting as Secretary of the Parkstone Golf Club, in which he was very popular. He continued in this capacity until about 1944, when rather poor health began to restrict his activities.

Those who served under Mr. Weaver will bear testimony to his unfailing good humour. His cheerful disposition and ready smile made bearable the difficult times of stress and pressure, to which work is always liable. He leaves a widow and one son.

Mr. Weaver joined The Institution in 1910 as an Associate Member and was elected a Member in 1922. H. F.

MONOGRAPHS AND PAPERS
published individually this month

Synopses of monographs and papers published individually before the next issue of the Journal are given below, and, unless otherwise stated, their dates of publication are this month. Reprints of all papers are available about two months after publication in the Proceedings. When ordering please quote serial number of paper or monograph. Books of 8 vouchers may be obtained from the Secretary, price 10s. each.

MONOGRAPHS

A Graphical Approach to the Study of Irregularities in Transmission Lines *Monograph* 234 R

W. T. BLACKBAND, M.SC.

The effects of an irregularity of characteristic impedance in a transmission line are displayed graphically on a transmission-line circle diagram. This presentation shows qualitatively the major factors which determine the changes in voltage standing-wave ratio and phase produced by a single irregularity or by a large number of irregularities distributed along the line. This analysis is not limited to matched transmission lines as are the statistical methods. The resonance of a disc-spaced transmission line at super-high frequencies is considered. The method developed by Cotte for the determination of impedance variation along a transmission line by harmonic analysis of the distribution of irregularities is discussed in terms of the graphical approach, and a possible simplification to the experimental method is suggested.

Electric Field Strength between Crossed and Parallel Circular Cylinders *Monograph* 235

P. G. HARPER, B.SC., PH.D., *and* J. J. O'DWYER, B.SC., B.E., PH.D.

An approximate method is given for evaluating the maximum field strength between charged circular cylinders whose axes are either parallel or perpendicular. The approximate formula is compared with exact results and shows an error of less than $\frac{1}{2}\%$ for a separation of one diameter. If the error in the approximate formula for crossed cylinders is of the same order, then the difference between the results for the crossed and parallel cases is significantly greater than this error.

Fundamental Radio Scatter Propagation Theory *Monograph* 236 R

The late E. C. S. MEGAW, M.B.E., D.SC.

The monograph presents a detailed theoretical treatment of the problem of beyond-horizon radio scatter propagation. The form for the spectral density of refractive-index fluctuation, assumed the same as that of velocity fluctuation, is derived from the universal equilibrium theory of turbulence. It is used to predict the spectral densities and magnitudes of brightness fluctuation and angular-deflection fluctuation for light from a stellar source, and of field-strength fluctuation for line-of-sight radio propagation. These predictions are compared with experimental data, and support is thereby obtained for the theoretical form of the refractive-index fluctuation spectrum. The height variation of the intensity of the refractive-index fluctuations is derived from the experimental data. There follows a detailed treatment of the beyond-horizon case of radio scatter propagation, including a full analysis of the influence of the geometry of the scattering volume on the received field-strength. It is shown that the form of the scattering cross-section implied in the results is compatible with those obtained in different treatments, based on idealized assumptions.

An Instrument for the Absolute Measurement of Low-Level Microwave Power in the 3 cm Band *Monograph* 237 R

PROFESSOR A. L. CULLEN, PH.D., B.SC.(ENG.), *and* H. A. FRENCH, B.SC.(ENG.)

The monograph describes an instrument termed a 'vibration wattmeter' that consists of a cavity in which is suspended a thin metal rod mounted on a fine glass spindle with a quartz fibre suspension. The rod is free to execute torsional oscillations in the horizontal plane.

The oscillating system receives periodic impulses from the interaction between the metal rod and the electromagnetic field within the cavity, and by the automatic switching of the microwave source a steady amplitude of mechanical oscillations can be maintained. The amplitude of these oscillations is measured by means of a small mirror attached to the spindle and a lamp-and-scale arrangement.

The relationship between the power delivered to the cavity and the amplitude of the mechanical oscillations can be found theoretically, and with knowledge of the specific couple of the quartz fibre suspension and of the damping factor of the mechanical system, measurements of power can be made.

The instrument measures microwave power with an error estimated as not exceeding $\pm 2\%$. The measurement is absolute, since the calibration depends only on measurements of mass, length and time.

Double-Slab Arbitrary-Polarization Surface-Wave Structure *Monograph* 238 R

ROBERT E. PLUMMER, B.S., *and* ROBERT C. HANSEN, PH.D.

A single earthed dielectric slab cannot propagate both polarizations of surface waves with equal velocities, and so a more complex structure such as a double-layer slab is needed. The nature of surface waves on two-layer earthed-slab structures is studied quantitatively, and conditions are derived that allow for equal velocities of both polarizations; a situation that will allow a wave of arbitrary or circular polarization to propagate. The upper slab must have a greater dielectric constant, and the square of the inverse velocity ratio (of the surface wave compared with free space) is constrained to lie in a range only slightly greater than that between the two dielectric constants. Extensive numerical data for the design of these arbitrary polarization structures are included.

A Note on the Excitation of Surface Waves *Monograph* 239 R

PROFESSOR A. L. CULLEN, PH.D.

The paper gives an extension of results on the launching efficiency of surface waves obtained in a previous paper.

In particular, a study is made of the effect on the launching efficiency curves of varying the ratio k_1/k, which is a measure of the surface reactance of the guiding surface.

Intermodulation Distortion due to Fading in Frequency-Modulation Frequency-Division Multiplex Trunk Radio Systems *Monograph* 240 R

L. G. MEDHURST, B.SC., *and* MURIEL HODGKINSON, B.SC.

Increased intermodulation distortion in frequency-modulation frequency-division-multiplex trunk radio systems is generated under fading conditions when the fade is due to the presence of one or more echoes. The distortion level is not simply related to the fading depth, but depends in a rather complicated way on the parameters of the echoes responsible for the fade. As a guide for future experimental work, the authors of the monograph have theoretically investigated this dependence, both for single-echo and for multi-echo fading. For the second, a simple formula has been developed for the worst intermodulation distortion due to a system of echoes of given amplitudes and delay times. Numerical results are given for a particular 22·5 dB fade whose echo structure was derived experimentally.

The authors conclude that nothing can be deduced, from measurements of fading depth alone, about the magnitude of intermodulation distortion associated with fades generated by cancelling echoes.

PAPER

Transistor Circuits and Applications *Paper* 2368 R: *Part B*

A. G. MILNES, D.SC.

Junction-transistor circuits are reviewed, and new concepts and trends in design are discussed. Improvements in transistor ratings are described, but special transistor types such as tetrodes, *p-n-p-n* and unipolar devices are not considered.

Basic applications surveyed include low-level and power amplifiers, square-wave and sinusoidal oscillators, power convertors and regulators, waveform-shaping and computing circuits, and low-level and power-switching circuits. Numerous references are given.

Transistors are capable of supplanting thermionic circuits in all except high-frequency applications (about 10 Mc/s with currently-available units). High temperatures present limitations in military applications, until silicon transistors are widely available. In more general applications, such as the entertainment field, cost is at present an important limiting consideration.

To be read on the 15th May.

SOME RECENT BOOKS

L. BRILLOUIN

SCIENCE AND INFORMATION THEORY

NEW YORK: ACADEMIC PRESS. 337 PP. £2 14S. 6D.

This book fills an important gap. The originators of communication theory, Norbert Wiener and Claude Shannon, were mathematicians, and their classic books and papers maintain a mathematical standard far above the level of most electrical engineers. The popular books, on the other hand, mostly fall short of the level desired by a *creative* electrical engineer, who wishes to put the general principles of communication theory to practical use. Nobody is better qualified to fill this gap than the author. Professor Leon Brillouin, for more than twenty years a leading personality in the development of short-wave and microwave communication, is an outstanding physicist who has a full understanding of the difficulties of electrical engineers who want to master this by no means simple subject. Nothing is assumed about the reader except familiarity with the calculus and with the elements of probability theory. Everything else, from Fourier series to thermodynamics, is derived and explained from first principles. The book is an almost complete compendium of the most important papers on information theory, even of its ramifications into physics, linguistics and semantics, and in almost every case the author has achieved remarkable feats of interpretation and of logical lucid presentation.

About half of the book is given up to the elucidation of the fundamental, but by no means simple, connection between Shannon's measure of information and thermodynamical entropy, with a truly fascinating exorcism of Maxwell's demon, which is for the most part the author's own work. The imprint of his hand is on every page, but particularly so in the chapters on Fourier analysis, including crystal analysis by X-rays, and in those on Brownian motion and noise. The brilliant discussion of noise in electric circuits may be recommended even to those who do not wish to give much time to communication theory, but would like to have a grasp of noise problems beyond the mechanical application of formulae.

A résumé of some of the main chapters will convey an idea of the wide scope of the book; they deal with the definition of information, redundancy in the English language, coding and channel capacity, error detecting codes, signal analysis, thermodynamics, thermal agitation and Brownian motion, thermal noise in electric circuits, the negentropy principle, Maxwell's demon, writing, printing, reading and computing.

It may be hoped that, apart from introducing many engineers into this new and important field, this book will have a beneficial effect by correcting widely current misconceptions, which have arisen because there are so few electrical engineers who understand thermodynamics. The price is moderate, and students who buy this book will in all probability consult it repeatedly throughout their lives.

A. GIET

ABACS OR NOMOGRAMS

LONDON: ILIFFE. NEW YORK: PHILOSOPHICAL LIBRARY. 234 PP. 35S.

Nomography was originally a product of French mathematical genius. Here is a translation (by J. W. Head and H. D. Phippen) of a modern French text, written for the engineer rather than the mathematician. No attempt is made to be as exhaustive as, say, the well-known work by Allcock and Jones, and indeed the author states that this new book is intended as complementary to it. The reader does not need

any advanced mathematical equipment and there is no mention of determinants. All the types of diagram in reasonably common use are included, and reference is also made to the little-known circular nomogram. There are numerous examples, though these are nearly all based on mechanical engineering practice and so are not of much interest to the electrical engineer. It is, perhaps, natural to use mathematical functions to illustrate the types of diagram; thus there is no reference to the fact that nomograms, no less than ordinary graphs, may represent non-mathematical functions such as magnetic relations and saturation phenomena. The first section is devoted to what are styled Cartesian abacs, these being little more than normal graphs with families of curves. The second section on alignment charts opens academically with a treatment of the properties of parallel co-ordinates; the student would look in vain for a general explanation of the charts. The development is, in places, so detailed as to lag seriously behind the ordinary reader's perception. There is no index and, if a further edition is called for, this omission should be remedied. The engineer, no less than the student, will find this text a most useful source book, as well as a logical development of the subject.

J. THOUREL

LES ANTENNES

PARIS: DUNOD. 453 PP. £5 APPROX.

In this book the emphasis is upon the practice of radio-aerial design rather than upon the generalized theory of aerials; however, enough theory is introduced to unify the subject and to make the book much more than a catalogue of aerial types. The subject of aerial design is so complex that no one can write with detailed personal experience of all the specialized sections of the subject, and each author gives emphasis to his own specialty. In this instance the author is a specialist in pencil beam aerials, and this part of the subject is treated with special thoroughness, the process of design being considered in detail and assessments made of the relative worth of alternative practices in various circumstances.

The explanations given are lucid and detailed throughout, the literary style is simple and the reader with only an indifferent knowledge of French will meet with little difficulty. This book is recommended for specialist libraries; it should be studied by specialists in large-aperture microwave aerials, and by those contemplating the writing of textbooks on aerials.

A clear and simple account is given of the fundamentals of aerials, of the optics of electromagnetic waves, of the theory of radiation from grouped sources and the principle of the multiplication of diagrams. Detailed data are presented for the mutual impedance between dipoles, and the methods of allowing for mutual effects are explained.

The cigar aerial, which is not well known in England, is treated as a dielectric-rod aerial, and the relatively high gains achieved with this construction are explained. For rhombic aerials the design details for broad-band impedance matching, for optimum gain, and for desired vertical angle of shoot are considered thoroughly.

An account of Kottler's equations introduces a study of the radiation from large apertures such as those of horn or parabolic reflector aerials. These chapters are thorough, covering the limits of mechanical tolerance for high-gain systems and the design of primary feeds in order to achieve a desired amplitude distribution across the aperture. An especially good account is given of the methods of achieving 'cosec' patterns by using multiple feeds or double-curvature reflectors.

In any textbook there are weaknesses; in this one more references to original papers would add greatly to its usefulness, because these contain many practical details which would be out of place in a textbook. The addition of captions would add to the intelligibility of the figures. It is suggested that some account of the methods of measuring aerial radiation pattern and gain could be usefully added, and that the Cartesian form of circle diagram should be explained as well as the Smith chart, because there is no doubt that each form of the chart has its special usefulness. There are a misleading statement and diagram which imply that there can be radiation along the axis of a thick dipole.

J. W. T. WALSH

PLANNED ARTIFICIAL LIGHTING

ODHAMS. 192 PP. 25S.

This book deals comprehensively with all the main factors involved in lighting planning, including lighting requirements, task analysis, lamps, lighting equipment, lighting design procedure and data, and light measurement. The concluding section deals with lighting for particular purposes such as inspection, display and spectacle, hazardous situations, street lighting, flood-lighting and decorative lighting. The book is indexed and particularly well illustrated and produced.

As the author has pointed out, it is not a textbook but a work of reference for those dealing with practical lighting problems. The extreme shortage of books of this nature arises out of the difficulty, inherent in the subject, that good lighting cannot be achieved by precedent but only out of knowledge, experience and imagination applied freshly to each installation. The author has wisely, therefore, not bypassed fundamentals but rather has restated them together with their practical expression. The result is not a number of blue prints but a treatment of the essentials of lighting planning which will usefully augment existing data, assist students and architects in the appreciation of lighting problems and help practising lighting engineers by clarifying the fundamental background of lighting and relating it to their work.

Any such marriage of theory and practice must, when carried out within the compass of less than 200 pages, do rather less than justice to either, but Dr. Walsh has selected wisely and has contrived not only to provide the essential design data but also to give practical effect to modern glare concepts. He is to be commended also for introducing in a practical work the 'equivalent square room' principle of assigning the 'room index'. Criticisms which may be made relate to omissions or deficiencies in available data, which are not a reflection on the author but on the scantiness of the information at hand. Data on the depreciation of fittings, for instance, is still not forthcoming, and the stop-gap expedient of adding a more or less universal 25% allowance for this is still used. Similar generalities in default of more precise data occur in the section on decoration. The design data, though an excellent summary of all available, leave many gaps to be filled in by experience or intelligent guess-work.

Altogether this is an authoritative work which is likely to remain the best of its kind until the translation of new lighting concepts into manageable data becomes an accomplished fact. This expectation is sufficiently remote to give this book many years of leadership in its own field, to which it is entitled both by its content and by the eminence of Dr. Walsh.

Denotes that the publication is also in the Lending Library. The publications cannot be bought through The Institution; the publishers and the prices are given only for the convenience of members.

LIBRARY ACCESSIONS

BOOKS

ACTON SOCIETY TRUST 331

Management Succession. The Recruitment, Selection, Training and Promotion of Managers

London, Acton Society Trust, 1956. pp. 139. 28 × 19 cm. 10s.

Results of research undertaken under the Acton Society Trust to discover the action being taken by large organizations to ensure that suitable men are available when needed on their establishments to fill managerial vacancies.

ARGUIMBAU, L. B. 621.385

Vacuum-tube Circuits and Transistors*

London, Chapman and Hall, 1956. pp. ix, 646. 23 × 15 cm. £4 2s.

This is really a new edition of 'Vacuum-tube Circuits' by the same author, which was published in 1948. It contains two new chapters on transistors, one on transit time and one on noise.

ARGUIMBAU, L. B., and STUART, R. D. 621.396.619

Frequency Modulation*

London, Methuen, 1956. pp. vii, 96. 17 × 11 cm. 8s. 6d.

A description of frequency modulation is followed by a more formal mathematical analysis. There is a detailed discussion of the various types of interference and how their effects can be minimized. This book was reviewed in the April issue.

BERKELEY, E. C. 518.5

Computers. Their Operation and Applications*

London, Chapman and Hall, 1956. pp. 365. 22 × 15 cm. £3 4s.

A description of automatic digital and analogue computers including certain large American installations. Applications of automatic computing machines are discussed.

BRILLOUIN, L. 621.391

Science and Information Theory*

New York, Academic Press, 1956. pp. xviii, 320. 23 × 15 cm. £2 14s. 6d.

This is a detailed treatment, much of which will be of interest to those concerned with applications in telecommunication and computing. It discusses the connection between information and entropy. This book is reviewed on p. 293.

CARROLL, J. M. 621.39.049

Mechanical Design for Electronics Production*

London, McGraw-Hill, 1956. pp. xix, 348. 23 × 15 cm. £2 9s.

This is a detailed practical work which deals with the mechanical design of equipment, including sheet-metal work, welding, shielding, potting, etc., with drive and control mechanisms, with wiring, soldering and printed circuits, and with many other aspects of equipment construction.

COCKING, W. T. 621.397.62

Television Receiving Equipment. 4th ed.*

London, Iliffe, 1957. pp. ix, 454. 21 × 14 cm. 30s.

This book has been considerably modified and rewritten to take account of developments since the previous edition was published in 1950. The treatment of electromagnetic deflection has been considerably expanded and synchronizing and interlacing are more fully treated. Automatic-gain-control methods and multi-channel tuners are described.

CZECH, J. 621.317.755

The Cathode Ray Oscilloscope. Circuitry and Practical Applications*

London, Cleaver-Hume, 1957. pp. xii, 340. 23 × 16 cm. £2 17s. 6d.

A practical description of the cathode-ray tube and the construction of the cathode-ray oscilloscope, including power supplies, the time-base generator and deflection amplifiers, is followed by a discussion of their applications to measurement. These include the measurement of amplitude, phase and frequency, and the use of the oscilloscope as a null indicator in a.c. bridges. Practical examples with over 600 oscillograms illustrating various uses are then given. There are precise details for the construction of two oscilloscopes and a time-base expansion unit. This book will be reviewed in a future issue.

DOUGLAS, A. 681.8

The Electrical Production of Music*

London, Macdonald, 1957. pp. 223. 22 × 14 cm. 28s.

Examines the sounds of orchestral instruments, explaining how they are produced and analysing their composition. Describes magnetic, electrostatic and photo-electric tone generators and valve oscillators, and indicates how these can be made to simulate ordinary musical instruments or produce new sounds and effects. The design principles and characteristics of loudspeakers as reproducers of sound are discussed, and in a final chapter possible future developments in the electrical production of music are considered.

EHLERS, W. 621.315.2

Kabel-Herstellung. Kabelaufbau, Werkstoffe Verfahrenstechnik (The Technique of Cable Manufacture)

Berlin, Springer, 1956. pp. xii, 433. 23 × 15 cm.

Discusses the composition and, in particular, the manufacture of cables for high- and low-voltage power circuits and for telecommunication purposes. The survey, which is a detailed one, covers submarine cables, sheathing, and a wide variety of insulating materials. Many of the illustrations show manufacturing processes. There is an extensive bibliography.

EVERITT, W. L., and ANNER, G. E. 621.392

Communication Engineering. 3rd ed.*

London, McGraw-Hill, 1956. pp. xi, 644. 24 × 16 cm. £3 7s. 6d.

It is nearly twenty years since the previous edition was published. Not surprisingly, therefore, this well-known work has been completely revised. It deals with the fundamentals of linear network analysis and synthesis including the use of unilateral elements.

FAIRWEATHER, D., and RICHARDS, R. C. 621.396.611.21

Quartz Crystals as Oscillators and Resonators*

Chelmsford, Marconi's Wireless Telegraph Co., 1956. pp. 56. 7s. 6d.

This is a practical work intended mainly for those concerned with the design of equipment using quartz crystals.

FISHER, D. H. 621.397.62

V.H.F. Television Tuners*

London, Heywood, 1956. pp. vii, 136. 22 × 14 cm. 21s.

A practical work which gives precise details in the form of circuit diagrams, values of components, and other data and illustrations for anyone wishing to construct a tuner. It also deals with production testing and servicing.

FLÜGGE, S. (Editor) 53

Handbuch der Physik. Band XV. Kältephysik II. (Encyclopedia of Physics. Vol. XV. Low-Temperature Physics II)

Berlin, Springer, 1956. pp. vii, 477. 25 × 16 cm. £7 13s. 2d.

This fifteenth volume in the series is entirely in English. It comprises five chapters covering temperature magnetism, liquid helium, adiabatic demagnetization and both the theoretical and experimental aspects of superconductivity.

GÖNNINGEN, H. 621.319.4

Der Papier-Kondensator (Paper Condensers) 2nd ed.

Schlitz, Gönningen, 1956. pp. viii, 350. 21 × 14 cm. £4 13s.

Deals with the design, manufacture, testing and faults of paper capacitors. All types are dealt with, and operating conditions and applications are discussed. This book will be reviewed in a future issue.

GROUNDWATER, I. S. 697

Solar Radiation in Air Conditioning*

London, Crosby Lockwood, 1957. pp. 125. 22 × 14 cm. 25s.

A practical work for consulting engineers, architects and air-conditioning engineers. Whilst concerned primarily with heat gains of structures in hot countries it gives useful information on the intensity of the sun's rays, and heat absorption by the atmosphere and by building materials, and compares methods of calculating heat gains.

GROVER, J. H. H. 621.396.93

Radio Aids to Air Navigation*

London, Heywood, 1956. pp. x, 138. 22 × 14 cm. 21s.

Written with the Ministry of Transport and Civil Aviation licence requirements for airline pilots and navigators in mind, this book explains the principles of operation of modern equipment.

GUÉRON, J., LANE, J. A., MAXWELL, I. R., and MENKE, J. R. (Editors) 621.039

The Economics of Nuclear Power including Administration and Law. Volume I*

London, Pergamon, 1956. pp. xii, 513. 23 × 15 cm. £6.

A collection of papers by a number of eminent authors surveying the reserves of conventional fuels and future world energy requirements. It discusses capital costs, operating costs of nuclear-power stations and the importance of breeder reactors. Administrative and legal problems are considered, particularly with regard to the safety and protection of workers. This book will be reviewed in a future issue.

HUNTER, L. P. (Editor) 621.38

Handbook of Semiconductor Electronics. A Practical Manual Covering the Physics, Technology, and Circuit Applications of Transistors, Diodes, and Photocells

London, McGraw-Hill, 1956. pp. xvii, 601. 23 × 15 cm. £4 10s.

A detailed work which describes first the characteristics and action of transistors, the physics of electrical conduction, and the rectification in solids. The preparation of the raw materials and the manufacturing techniques are then explained. A third section deals with the principles governing circuit design for various applications and using different types of transistor. There is an extensive bibliography.

JORDAN, H. 621.313-758

Der geräuscharme Elektromotor (Noiseless Electric Motors)

Essen, Girardet, 1950. pp. 100. 21 × 15 cm. 26s.

A book intended for the specialist. It gives a detailed mathematical analysis of noise produced by electric motors and indicates methods of reducing this form of disturbance.

KENT, W. R. L., GUNN, D. C., and MURRAY, G. F. J. 621.18

Boiler Plant Instrumentation

London, Heywood, 1957. pp. vii, 159. 22 × 14 cm. 21s.

Describes the various types of solid- and liquid-fuel boilers indicating basic measurements for efficient operation and for keeping smoke to a minimum. The advantages of instrumentation and automatic control of boilers are discussed.

KROES, Th. J. (Compiler) 621.385

Tube Selection Guide 1956-1957.

London, Cleaver-Hume, 1957. pp. 125. 24 × 15 cm. 9s. 6d.

Gives details of Philips valves.

LEGGET, R. 624.1

Rideau Waterway

Toronto, University of Toronto Press, 1955. pp. ix, 249. 23 × 15 cm. £2.

This is a chain of lakes and rivers made navigable by locks and interconnecting canals. Now primarily used as a holiday area it was originally built to link Kingston and Ottawa. The book tells of the building of the canal, by soldiers and civilian labour, through wild country including bush, swamp and rock.

MILLER, W. E. (Revised by SPREADBURY, E. R. W.) 621.397

Television Explained. 6th ed.*

London, Iliffe, 1957. pp. xvi, 175. 22 × 14 cm. 12s. 6d.

A simple, practical book which deals with television receiving circuits and aerials, and the installation and operation of receivers. This latest edition takes account of the modifications in design brought about by the availability of an alternative programme.

MILLMAN, J., and TAUB, H. 621.374

Pulse and Digital Circuits*

London, McGraw-Hill, 1956. pp. x, 687. 23 × 15 cm. £4 14s.

This is a book for advanced students and research workers. It describes and analyses the circuits and techniques which are common to many of the newer fields of electrical engineering. A review of amplifier circuits and passive networks leads up to a discussion of pulse circuit techniques, unconventional or special circuits, and where these are dealt with mathematically a physical explanation is also given. Worked examples are included in each chapter.

MONTGOMERIE, G. A. 518.5

Digital Calculating Machines* and their Application to Scientific and Engineering Work

London, Blackie, 1956. pp. 262. 22 × 15 cm. 30s.

Describes the design principles of the various types of digital computing machines and the way these machines can be used for calculations of varying complexity. The descriptions cover simple hand-operated machines, punched-card machines and electronic sequence-controlled equipment.

MÜLLER-LÜBECK, K. 621.395.645

Der Kathodenverstärker in der elektronischen Messotechnik. (Cathode Followers in Electronic Measurement)

Berlin, Springer, 1956. pp. viii, 155. 23 × 15 cm. £2 1s.

The theory of cathode followers and peak-voltage rectification is dealt with first. The various measuring instruments are described

including those used in television engineering, for the testing of gas-discharge and selenium-type rectifiers, and for cosmic-ray studies. The book, which is intended for the specialist, is well illustrated with circuit diagrams, graphs and oscillograms.

NAIRN, I. 71

Counter Attack against Subtopia

London, Architectural Press, 1956. pp. 435. 31 × 25 cm. 12s. 6d.

'Outrage' demonstrated the way the English landscape is being spoilt, not only by pylons, towers, hoardings and the like, but also by unsightly rural developments. This volume is a sequel giving, again photographically, practical examples of the right way to do things, so proving that the complaint in 'Outrage' is fully justified.

NICHOLS, M. H., and RAUCH, L. L. 621.398

Radio Telemetry. 2nd ed.*

London, Chapman and Hall, 1956. pp. xiii, 461. £4 16s.

Deals fully with the different ways of modulating a carrier and the different systems of multiplexing, and discusses these relative to noise and errors in communicating a signal. Techniques of radio telemetering are referred to, but the book is a theoretical rather than a practical treatment of the subject. There is an extensive bibliography.

NODELMAN, H. M., and SMITH, F. W. 517

Mathematics for Electronics. With Applications*

London, McGraw-Hill, 1956. pp. viii, 370. 28 × 15 cm. £2 12s. 6d.

By means of a collection of problems, some illustrated by model answers, the student is shown the usefulness of mathematics for solving engineering problems. The applications include the use of the calculus, dimensional analysis, methods of checking the validity of engineering equations, determinants, matrix algebra, and the use of series and differential equations.

PHILIPS ELECTRON TUBE DIVISION 621.385

U.H.F. Tubes for Communication and Measuring Equipment

London, Cleaver-Hume, 1957. pp. ix, 61. 24 × 16 cm. 9s. 6d.

Describes tubes developed for use at frequencies in the centimetric range and differing fundamentally in design and construction from conventional tubes.

PHILIPS ELECTRON TUBE DIVISION 621.385

Tubes for Computers

London, Cleaver-Hume, 1957. pp. ix, 51. 24 × 16 cm. 9s. 6d.

Describes vacuum tubes specially designed for use in high- and low-speed computers.

PYKE, M. 658.2

Automation: its Purpose and Future*

London, Hutchinson's Scientific and Technical Publications, 1956. pp. 191. 22 × 14 cm. 16s.

This is not a book written for the specialist or the engineer but one which the layman can follow. It considers the social implications of automation, discusses the use of computers for controlling processes and products, describes the extent to which automation has already been introduced and indicates the shape of future developments.

RICHARDSON, E. G. (Editor) 534

Technical Aspects of Sound. Vol. II. Ultrasonic Range, Underwater Acoustics*

London, Elsevier, 1957. pp. xii, 412. 24 × 15 cm. £3 10s.

Volume I deals with audio frequencies. This volume discusses the propagation of sound in the atmosphere and through water. Ultrasonic transducers and applications of ultrasonic vibrations are described. Absorbers for water-borne sound are discussed, and propeller, jet and other aircraft noises and underwater propulsion noises are considered.

SLOT, G. 534.85

HI–FI from Microphone to Ear. Modern Sound Recording and Reproduction Technique*

London, Cleaver-Hume, 1956. pp. viii, 169. 21 × 14 cm. 17s. 6d.

A detailed description of gramophone recording and reproducing equipment and the manufacture and care of records.

WALSH, J. W. T. 628.9

Planned Artificial Lighting*

London, Newnes, 1956. pp. 192. 23 × 15 cm. 25s.

Indicates how, by analysing the requirements of a lighting system and making a suitable choice from a wide range of lamps, equipment and fittings, a suitable installation can be designed for domestic or industrial interior or exterior purposes. This book is reviewed on p. 294.

WARBURTON-BROWN, D. 621.365.5

Induction Heating Practice. A Handbook on the High-Frequency Induction Process for all Concerned with Engineering Production

London, Odhams, 1956. pp. 192. 22 × 15 cm. 21s.

This practical work deals with the design of work coils and inductors, and the design of components or assemblies to facilitate brazing, soldering, hardening, and annealing.

WILSON, P. 534.85

The Gramophone Handbook*

London, Methuen, 1957. pp. 227. 20 × 13 cm. 15s.

A comprehensive survey of present-day recording and reproducing techniques. Although intended to be read by the layman it is undoubtedly a technical work containing much useful information.

OTHER PUBLICATIONS

BRITISH THOMSON-HOUSTON CO.

Proceedings of the BTH Third Summer School in Electrical Engineering

Rugby, B.T.H., 1956. pp. 154. 27 × 21 cm.

BROWNSEY, C. M.

The Problem of Noise with Particular Reference to Transformer Noise.

Leatherhead, Central Electricity Authority, Memoir No. 3, 1956. pp. 56. 28 × 20 cm. 10s.

FOX, L.

The Use and Construction of Mathematical Tables

London, National Physical Laboratory, Mathematical Tables, Vol. I, 1956. 60 pp. 28 × 22 cm. 17s. 6d.

INTERNATIONAL COMMISSION ON RULES FOR THE APPROVAL OF ELECTRICAL EQUIPMENT

Specification for Fuses for Domestic and Similar Purposes

Arnhem, C.E.E., Publication 16, 1955. pp. 89. 21 × 15 cm.

McDONALD, D.

Power Transformers for High-Voltage Transmission with Special Reference to their Design

Edinburgh, Bruce Peebles, Publication No. TP. 101, 1957. pp. 64. 26 × 20 cm.

Forthcoming Events

All meetings are held at Savoy Place, beginning at 5.30 p.m. (tea at 5 p.m.), except where otherwise stated. The nature of the meeting is indicated by the following key:

E EDUCATION DISCUSSION CIRCLE
M MEASUREMENT AND CONTROL SECTION
R RADIO AND TELECOMMUNICATION SECTION
S SUPPLY SECTION
U UTILIZATION SECTION

After a paper that has now been published is added the month that a synopsis has appeared in the *Journal* under 'Monographs and Papers published individually this month', i.e. about the time the paper has been published as a separate. A paper that has not yet been published will be available at least ten days before the meeting at which it will be read.

May 1957

R **18** *Saturday* Repeat Radio and Telecommunication Section Visit to B.B.C. and I.T.A. Television Transmitting Stations

20 *Monday* Discussion on the Report on the Development of Hydro-Electric Power in the Soviet Union. (Joint Meeting with The Institutions of Civil and of Mechanical Engineers at The Institution of Civil Engineers, Great George Street, Westminster, S.W.1; copies of the Report are available from the Secretary of The Institution of Electrical Engineers)

S **22** *Wednesday* J. M. MAGOWAN 'Voltage Performance of Series Capacitors in Transmission and Distribution Lines' (Paper No. 2252 S) *Synopsis:* December 1956 (The paper will be read by L. L. LANGTON)

23 *Thursday* ANNUAL GENERAL MEETING (5.30 p.m.) *followed by* A. D. BOOTH, D.SC., PH.D. Lecture on 'General Applications of Digital Computers'‡ (At approximately 6.30 p.m.)

S **25** Supply Section Visit to Oxford

U **31**–**June 2** *Friday–Sunday* Utilization Section Visit to Stratford on Avon

June 1957

M **14** *Friday* Measurement and Control Section Visit to Leicester

E **28** *Friday* Exhibition of Apparatus for Teaching Electrical Engineering (At Northampton Polytechnic, St. John Street, E.C.1, 2.30–8.30 p.m. Refreshments, 5.30–6)

July 1957

1–5 *Monday–Friday* Summer Meeting in the North-Western Centre

September 1957

S **5–9** *Thursday–Monday* Supply Section Visit to Belgium

R **18–22** *Wednesday–Sunday* Radio and Telecommunication Section Visit to the Netherlands

Elections and Transfers

The following elections and transfers approved by the Council are effective from the 4th April 1957.

ELECTIONS

Graduates

ALLCOCK, Alexander Williams
ALLEN, Raymond Edward
BELL, John, B.SC.
BERESFORD, Marcus Orton
BERRY, Allan David, B.SC.(ENG.)
BISHOP, Kenneth Albert
BODY, Peter Reginald
BOGNER, Robert Eugen, B.E.
BRIARS, Colin Hubert
BROUCHER, Herbert Geoffrey
BURTON, Alan Christopher Charles
CAPPER, Brian Harford
CATTERALL, Sydney
CHOY, Gay, B.E.
CHRISTIE, Taguen Brisland
CROOKES, Leslie
DENNISON, Roland Wilfred
DEVLIN, Jack Anthony
DIGGINS, John Francis
DOWELL, Joseph, B.SC.
EDWARDS, James Ieuan
ELLENDER, Brian Alfred
ELLIOTT, Richard Gordon Douglas, B.SC.(ENG.)
EVENS, Ronald Clarence
FITZGIBBON, Denis, B.E.
FORSTER, Kenneth, B.SC.
GOLDFINCH, Raymond Arthur
GOODMAN, Eric Aubrey
GOULD, David John
GREEN, Revel John
GREENLEES, Andrew, B.SC.
GREGORY, Barrie Archie
GRIGSON, Pilot-Officer Michael William Sayle, B.A., R.A.F.
HAGAN, John
HALL, Lt. James Weedy, B.A., R.N.
HANNAH, Neil Ratcliffe
HARRIS, Kenneth Thomas
HASLER, Edward
HEIMER, Hans
HEKTOEN, Bjarne Kare
HOBBS, Richard Ernest
HOOD, Derek Leslie
HOPE, John Alfred
HOWELLS, David Alan, B.SC.
HOYTE, John Merrishaw, B.A.
JONES, Kenneth
JONES, Raymond Lewis
JOUBERT, Pieter Johannes
KHAN, Mohammed Iqbal Hasan, B.SC.
KIDD, Geoffrey Shaw, B.SC.
KIRK, Eric Stanley
LANGRISH, Timaru Frank, B.E.
LEICESTER, William Lancelot
LEWIS, Donald
LLOYD, Christopher Glyn
LLOYD, Robert Goronwy, B.SC.
LOWE, Gerald
MAGEE, William Henry
MALTZ, Samuel Isaac, B.SC.(ENG.)
MILES, Terence John Rupert, B.A.
MORRISON, John Jack
MULLER, Johannes Christoffel, B.SC. (ENG.)
NATARAJAN, Radhanellore Chockalingam, B.E., M.S.
NICHOLS, Geoffrey Mills
NOBLE, Patrick Joseph
NORMAN, Eric Humphrey, B.SC.
NOVAK, Stephen Gabriel, B.E.
NOWERS, Christopher Peter
PAINES, David John
PAY, Rex George, M.SC.
PHILPOTT, Jack Kirwen
PUGH, Harold
REID, Donald Bruce
RICHARDSON, Alan
RIDPATH, Redmond Gordon
RINGELBERG, Levinus
ROWLEY, Geoffrey Charles
RUSHMER, Ronald Arthur
RYAN, John Thomas
SIMPSON, Lt. John Lawrence, B.A., R.N.
SMITH, Brian Booth, B.A., B.SC.
SMITH, Peter Derrick
SMITH, Roger, B.E.
SNAZELL, George Edward, B.SC.
STEPHENSON, John Brown, B.SC.
SYKES, Kenneth
TILLEY, Brian George, B.SC.
TOMKINS, John Henry, B.SC.(ENG.)
TOWLE, Leonard Christopher, B.SC.
TRUE, Ronald Bertram
TZAMBIRAS, John
WATERMAN, William
WILKINSON, Walter Edward
WISMARK, Michael Raymond Storm
WOOD, Alan Edgar
WOOD, Douglas Michael, B.A.
WOOD, Robert
WOODROFFE, Alan Reginald

Students

ADELAKUN, Josiah Fredric Akinlabi
ALLEN, Kenneth Royston
AMOS, Reginald George
ANDERSON, John Alexander Vernon
ARMSTRONG, Alan Frederick
ARTHUR, Michael Stephen
ATKINSON, Malcolm Thewlis
BAKER, John Gilbert Roswell
BASS, Ronald Paton
BELLAMY, Arthur Henry
BENNELL, David Walter
BENSTED, Christopher John Philip
BICKERTON, Peter Glyn
BILLCLIFF, Peter John
BLAKE, Denis Godfrey
BLAND, Richard John
BRADBURY, Michael Vincent
BRISTOW, Raymond Edward
BULL, Donald Malcolm, B.SC.
CARR, Derek Antony, B.SC.
CAUSTILL, Samuel Elias
CAYZER, John Anthony
CHINASINO, Stephen Moyin
CLISBY, Bryan Elliott
CLUGSTON, Thomas Richard
COCKBURN, Andrew John
COORAY, Thakshan Rohan
CROWTHER, Peter John
CURRIE, Donald James
DABORN, David Albert
DAVIES, Clive Lewis
DEMETRIOU, Voris Anthoniou
DENYER, Stuart
DINNIS, Alan Russel
DOOLEY, Brian Joseph, B.SC.
DREW, Ralph Francis
EDWARDS, John Brooks
ELLIMAN, Richard James
EVANS, Bruce
FARNSWORTH, Malcolm, B.SC.
FARNSWORTH, Ronald, B.SC.
FRENCH, Ian Peter, B.SC.
GARDNER, David
GIBSON, John
GRIMWOOD, Terence John
GROVER, Derrick John, B.SC.
HADWIN, Eric
HALL, Louis Christopher
HALMRAST, Leif
HOLLIS, Frank Charles
HUNTINGTON, Edwin Arthur
HURD, George Alan
JACKSON, Keith
JAMES, John Max
JAMES, Leighton Harris
JEFFERY, Gavin Wilson

Students (contd.)

JOHNSON, Donald Edward
JONES, Anthony David
JONES, Norman Frederick, B.SC.
KARAGHEUANIAN, Hagop Manuel
KERNAN, Campbell Houston
KNOWLES, Charles Roger
KOTHARI, Hemraj, B.SC.
KUMAR, Krishna
LEDGEWAY, Ronald
MACDONALD, Donald William
MANOLIAS, Constantinos
MARTIN, Ronald Austin
MAVROMIHALES, Andreas John
MEDINA, Anwer Husain, B.E.
MELBURN, George, B.SC.
MELDNER, John Adrian
MILLER, Dougald McKay
MORGAN, David Reid, B.SC.
MORGAN, John Adam
MORRIS, Robert Charles
MOSS, John Kenneth
MURRAY, Anthony
NALLIAH, Stephen Chelvarasa
NYE, Peter James
O'DOHERTY, Sean
OLDHAM, Derek Thomas
PALACHANDRAN, Gnanasegaram
PARKER, Colin
PHIL, Graham
PITCHER, Ronald
POWLEY, John Robert
PRICE, Clifford Clarence, B.SC.
PRIME, Ronald Clive
RAINE, William
RICHARDSON, Clive Edward
RIVLIN, Jonathan, B.SC.
ROBERTS, John Arthur
ROBERTS, Peter Kemp
RODGERS, David Henry
RUTHERFORD, Brian
SAUNDERS, Leith Roy, M.SC.
SAUNDERS, Trevor James
SELVANAYAGAM, Veeravagu Arumugam
SHEMMANS, Malcolm John
SIMPSON, Eric Ernest
SMITH, Albert Alan
SMITH, George Brian
SOAMES, David Spencer
STAFFORD, Michael Robert
TALBOT, Brian Pengelly
TEWSLEY, Eric William
THOMAS, Gwyn, B.SC.
TORR, Alan Cecil
TRATT, John Herbert
TRUEMAN, Ernest
URRY, John Brian Marshall
WAKEFIELD, John Robert
WALL, Brian Edward
WARRILOW, Paul
WASFI, Mahmud Ahmed
WHEATLEY, Robert George
WHITEHEAD, Brian Harry
WHITELEY, Michael Christopher
WILDE, Neville Arthur James
WILLIAMS, John Victor
WILSON, Donald
WINSOR, John Michael
WOLFENDEN, Brian Arthur
WOODCRAFT, John Lionel
XAVIER, Philip Francis

TRANSFERS

Student to Graduate

ADLARD, David Roger
AKROYD, Joe Speight, B.SC.(ENG.)
ARCHER, Brian Anthony
ARKINSTALL, Dennis
ATKINS, Peter James Frederick, B.SC.(ENG.)
BAGH, Jens Otto
BANERJEE, Hironmoy
BARBER, Reginald John
BARRON, John Bolton
BIRRELL, John
BLACK, Sydney Thomas Marshall
BOWLER, Peter, B.SC.(ENG.)
COOKE, Derrick, B.SC.TECH.
COOPER, Terence William
DAYSON, Ronald Cyril
DRYDEN, Colin
DYCHE, Robert
ERGATOUDES, Themistoclis Panayiotou
EVERETT, Patrick Nixon, B.A.
FLETCHER, Ivan Alfred, B.SC.
GEWITZKE, Roy Henry, B.SC.(ENG.)
GORDON, Colin Gilbert
HAFFAR, Osama Mohammad Nouri, B.ENG.
HENDERSON, James Duncan
HODGSON, David Livingstone, B.SC.(ENG.)
JELFFS, Michael William
JONES, Elis Pennant, B.SC.(ENG.)
JONES, Llewelyn Robert
KNIGHT, Geoffrey Brunton, B.SC.
LAX, Brian Keith
LENG, John
LISHMAN, Frederick James
LOFTING, Anthony Edward
MACDONALD, Donald Cumming, B.SC.(ENG.)
MERCER, Frank
MOLE, David Henry
MOORE, Dennis John, B.SC.(ENG.)
MORRISON, Ian Christie
MUDD, Herbert
PEARCE, John Arnold, B.SC.(ENG.)
PHIPPS, Peter Leslie
PICKWORTH, Miss Elisabeth Anne, B.SC.(ENG.)
POINTON, Dennis Samuel
POPE, Terence
ROBBINS, Anthony George, B.SC.(ENG.)
SHARP, Alan William, B.SC.(ENG.)
SMALLWOOD, Stanley Evan Frederick, M.SC.
THELWELL, Michael Joseph
TOMLINSON, Brian Arrandale, B.SC.TECH.
TURCZANSKI, Henryk, B.SC.(ENG.)
UPSTON, Raymond Alfred Ellis
VERRAN, Ronald Maurice, B.SC.
WHITEMAN, Donald Arthur
WOODCOCK, Roger, B.SC.(ENG.)
WOOLLARD, Roger Richard, B.SC.(ENG.)

ANNOUNCEMENTS TO MEMBERS

THE HOMES FUND

SUMMARY OF CONTRIBUTIONS RECEIVED TO 25TH APRIL 1957

	No. of Contributors	£	s.	d.
£1 000 and over	6	6 000	0	0
£100 to < £1 000	30	6 586	3	0
£5 to < £100	819	8 754	3	3
£2 to < £5	2 008	5 487	0	8
Under £2	21 746	11 301	17	1
		£38 129	4	0

APPOINTMENTS AND NOMINATIONS

RUTHERFORD COLLEGE OF TECHNOLOGY GOVERNING BODY

The Council have nominated Mr. H. H. Mullens, B.SC., MEMBER, to serve as their representative on the above Governing Body.

BRITISH STANDARDS INSTITUTION TECHNICAL SUB-COMMITTEE ON SWITCHBOARDS (ELE/10/10)

The Council have nominated Mr. T. M. H. Stubbs, ASSOCIATE, to serve as their representative on the above Sub-Committee.

CORRESPONDENCE

In view of the heavy volume of correspondence received daily at the offices of The Institution it is of the greatest assistance when members, in replying to letters received from the Secretary, quote The Institution's reference number. This saves the time of the routing staff and ensures that a letter not only reaches the department concerned without delay but can be immediately linked with the previous correspondence. It is also helpful when members state their class of membership.

REGISTER OF MEMBERS—CHANGES OF ADDRESS

Members are reminded that notifications of changes of address should be made to the Secretary of The Institution in London. Where a transfer from the area of one Local Centre or Sub-Centre to another arises as a result of a change of address, this transfer is automatically arranged by head-quarters and the member concerned need not notify also the Honorary Secretary of the Local Centre or Sub-Centre.

To obviate the possibility of errors in the records, members are particularly requested, when notifying a change of address, to give their full initials, their previous address and their class of membership.

GERMAN PUBLICATIONS

Members subscribing to the publications of Verband Deutscher Elektrotechniker e.V. are asked to note the following revised rates of subscription:

Elektrotechnische Zeitschrift edition A (ETZ-A) (*two numbers monthly*)	d.m. 30 (£2 10s.)
Elektrotechnische Zeitschrift edition B (ETZ-B) (*one number monthly*)	d.m. 21 (£1 15s.)
Elektrotechnische Zeitschrift editions A and B (*three numbers monthly*)	d.m. 45 (£3 15s.)
Nachrichtentechnische Zeitschrift (NTZ)	d.m. 28 (£2 7s.)

COURSE ON DIGITAL COMPUTERS

The British Council are arranging a course on digital computers for oversea scientists in industry, university teaching and research, from the 27th October to 9th November 1957. The course will comprise lectures, discussions, and visits to computing laboratories and installations of computing machines; it will survey available machine programming and machine applications. The base for the course will be London, where the lectures will be given. The Director of Studies will be Dr. A. D. Booth, Director of the Birkbeck College Computational Laboratory, University of London. The fee for the course is £42, which includes board and accommodation. Applications should be made to a local representative of the British Council, or the Director, Courses Department, The British Council, 65 Davies Street, London, W.1.

ESSAY COMPETITION

The publishers of *Research* invite entries for their 1957 Prize Essay Competition. Two separate sets of prizes are available—the *Research* prizes for an essay of about 3000 words based on some recent scientific work, not necessarily carried out by the competitor, and the *Sunday Times* prizes for an essay of about 1500 words suitable for publication in a general newspaper. For the *Research* prizes, which are of value £100 and £50, with an additional prize of £50 for competitors under the age of thirty, the essay should be so written that it is comprehensible by the non-specialist and in particular by an interested industrialist. For the *Sunday Times* prizes, which are of value £100 and £50, the essay should stress the relationship of a scientific discovery to the practical purposes of industry, economic life or human welfare.

The closing date for the competition is the 31st July 1957.

Full details will be supplied on application to *Research*, 4 and 5 Bell Yard, London, W.C.2.

BURSARIES IN HYDRO-POWER ENGINEERING

The Imperial College of Science and Technology, University of London, have recently announced that a number of Bursars in Hydro-Power Engineering will be elected in June 1957. The Bursaries, which have been financed by a manufacturing company, are of the value of £450–£600, depending on experience, and they are tenable at Imperial College for one academic year. Candidates should have an honours degree in engineering, or an equivalent qualification, and applications should be received before the 1st June by the Deputy Registrar, City and Guilds College, Exhibition Road, London, S.W.7, from whom further details may be obtained.

AUTOMATIC COMPUTING

A summer school in programme design for automatic digital computing machines will be held in the University Mathematical Laboratory at Cambridge from the 16th to 27th September 1957. The course will give basic training in the mathematical use of machines, dealing with the processes employed and their embodiment in programmes which specify the operation. A detailed syllabus and application form may be obtained from Mr. G. F. Hickson, Secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge, to whom the completed form should be returned not later than the 15th June 1957.

BRITISH CONFERENCE ON AUTOMATION AND COMPUTATION

The following notice was issued to the Press last month:

'Because of the rapid growth of the new industrial techniques popularly known as automation, which also comprise computation, process control and data processing generally, and of the many persons likely to be affected by their application, it became increasingly clear, towards the end of 1956, that there was an urgent need for the establishment of some central organism to afford liaison between all the interested organizations.

'A number of independent discussions took place, each having the object of setting up a suitable organization, and much useful preparatory work was done in this way. It was realized that, for further progress to be made, a very broadly based structure was desirable, and, at the invitation of The Institution of Civil Engineers, The Institution of Mechanical Engineers and The Institution of Electrical Engineers, exploratory conferences were held on 6th March and 16th April, as a result of which the representatives of some twenty organizations with interests in the fields of automation and computation, approved proposals for closer collaboration, and agreed to recommend them to their Councils for adoption. The proposals, if accepted by the bodies concerned, will result in the setting up of a British Conference on Automation and Computation which will be organized in three Groups of societies, having the following fields of interest:

Group A THE ENGINEERING APPLICATIONS OF AUTOMATION TECHNIQUES

Group B THE DEVELOPMENT AND APPLICATION OF COMPUTERS, AUTOMATIC CONTROLS AND PROGRAMMING TECHNIQUES

Group C THE SOCIOLOGICAL AND ECONOMIC ASPECTS OF AUTOMATION AND COMPUTATION PROCEDURES

'The following bodies would be invited to act as the conveners and sponsors of the three Groups:

Group A The Engineering Applications of Automation Techniques

Convener	Institution of Mechanical Engineers
Additional Sponsors	Institution of Civil Engineers Institution of Chemical Engineers Institution of Electrical Engineers Institution of Production Engineers

Group B The Development and Applications of Computers, Automatic Controls and Programming Techniques

Convener	Institution of Electrical Engineers
Additional Sponsors	Institute of Cost and Works Accountants Institute of Physics Office Management Association Society of Instrument Technology

Group C The Sociological and Economic Aspects of Automation and Computation Procedures

Convener	British Institute of Management
Additional Sponsors	Industrial Welfare Society Institute of Cost and Works Accountants Institute of Personnel Management Institution of Production Engineers

'An essential feature of the proposals is that liaison between the Groups should be established on a permanent basis from the outset, and it is foreseen that the central unit of the Con-

ference which will be established for this purpose will undertake such other duties as may be deputed to it by the Groups; e.g., the preparation of periodical digests of published papers falling within the fields of automation and computation.

'If the proposals are approved by the councils of the several societies represented at the exploratory conference, the conveners and sponsors of each Group will summon further meetings, to which will be invited representatives of all the bodies which appear to have interests in the particular Group, with a view to their membership and collaboration. Any other body would be very welcome to apply for membership of the Group or Groups in which it felt its interests lay. At these conferences detailed arrangements will be settled for liaison within the United Kingdom between the various bodies participating in the Groups, and between the Groups themselves, so that progress in the fields of automation and computation and their applications can be fostered, and so that . . . the British contribution to international conferences, and in the promotion of national conferences, on the subjects falling within their fields, can be focused.

'At the exploratory conferences there was unanimous agreement that the setting up of a new and all-embracing society to be concerned with automation was not required, but that great advantage to the country would ensue from the measures of collaboration now proposed, it being fully recognized that, in the framework of automation, the importance of the human side is equal to, if not greater than, that of the purely technological aspects.

'As has been indicated above, all societies and institutions interested in the subject will be most welcome to support the activities of the Conference by applying for membership of the appropriate Group or Groups.'

At their meeting on the 25th April 1957, the Council of The Institution gave their formal approval to the proposals, in the formulation of which they had already taken part.

Contents of the Current Issues of the *Proceedings*

DATE OF JOURNAL REVIEW OR SPECIAL ARTICLE

PART A. POWER ENGINEERING (APRIL 1957) See *Journal*, April 1957, p. 240.

PART B. RADIO AND ELECTRONIC ENGINEERING (MAY 1957)

Written discussion on **The Crystal Palace Television Transmitting Station** and **Band I Television-Transmitter Design, with particular reference to the Transmitters at Crystal Palace**

Special article to be published — PROFESSOR R. O. KAPP, B.SC.(ENG.)
Differences of Opinion about Dimensions (PAPER NO. 2167, SEPTEMBER 1956)

May 1957 — R. A. ROWDEN, B.SC.(ENG.), AND J. W. STARK
Long-Distance Propagation at 94·35 Mc/s over the North Sea (PAPER NO. 2345 R)

May 1957 — E. W. HAYES AND H. PAGE, M.SC.
The B.B.C. Sound Broadcasting Service on Very High Frequencies (PAPER NO. 2258 R, NOVEMBER 1956)

May 1957 — A. C. BECK, B.SC.(ENG.), F. T. NORBURY AND J. L. STORR-BEST, B.SC.(ENG.)
Frequency-Modulated V.H.F. Transmitter Technique with particular reference to the B.B.C. United Kingdom Service (PAPER NO. 2267 R, NOVEMBER 1956)

April 1957 — W. S. MORTLEY
Frequency-Modulated Quartz Oscillators for Broadcasting Equipment (PAPER NO. 2302 R, DECEMBER 1956)

April 1957 — PROFESSOR H. E. M. BARLOW, PH.D., B.SC.(ENG.), AND H. G. EFFEMEY
Propagation Characteristics of Low-Loss Tubular Waveguides (PAPER NO. 2326 R)

May 1957 — P. D. LOMER, M.SC., AND J. W. CROMPTON, B.E.
A New Form of Hybrid Junction for Microwave Frequencies (PAPER NO. 2356 R)

Written discussion on **Frequency-Modulation Distortion in Linear Networks**

Not yet reviewed — G. G. GOURIET **Bandwidth Compression of a Television Signal** (PAPER NO. 2357 R)

March 1957 — R. B. R.-SHERSBY-HARVIE, B.A., L. B. MULLETT, B.SC., W. WALKINSHAW, M.A., J. S. BELL, B.SC., AND B. G. LOACH, B.SC.
A Theoretical and Experimental Investigation of Anisotropic-Dielectric-Loaded Linear Electron Accelerators (PAPER NO. 2127 M, JULY 1956)

March 1957 — K. P. P. NAMBIAR, B.SC., AND A. R. BOOTHROYD, PH.D.
Junction-Transistor Bootstrap Linear-Sweep Circuits (PAPER NO. 2228 R, JANUARY 1957)

March 1957 — F. OAKES
Design Considerations of Junction-Transistor Oscillators for the Conversion of Power from Direct to Alternating Current (PAPER NO. 2299 R, JANUARY 1957)

March 1957 — J. C. HENDERSON, B.SC., AND J. R. TILLMAN, D.SC., PH.D.
Minority-Carrier Storage in Semi-Conductor Diodes (PAPER NO. 2293 R, JANUARY 1957)

Not yet reviewed — F. H. REYNOLDS, B.SC.(ENG.), AND M. W. ROGERS
A New Method for the Detection of Thin Conducting Films in Thermionic Valves (PAPER NO. 2335 R)

PART C. MONOGRAPHS (MARCH 1957) See *Journal*, March 1957, p. 187.

LONDON REPORT

ORDINARY MEETING

Stopping the Rot

A large gathering, drawn from many different fields of engineering, attended the presentation of the paper on *Cathodic Protection* by L. B. Hobgen, K. A. Spencer and P. W. Heselgrave, on the 7th March 1957. Unfortunately Mr. Spencer was unable to be present, but Mr. Hobgen introduced the paper, and Mr. Heselgrave replied very ably to the discussion.

The presentation of the paper was somewhat novel in that it included a colour film illustrating the electrochemical mechanism of corrosion. Animated diagrams illustrated the chemical reactions, with shots of laboratory experiments showing current flow and corrosion taking place on test samples, while shots of corrosion in full-scale experiments showed the amount of damage which could be caused.

Mr. Hobgen then gave a brief résumé of the paper, and emphasized the many factors that could affect the rate of corrosion and the method of its prevention. One point of interest is that corrosion often occurs only on the underneath of a pipe, and casual inspection may not reveal it.

Mr. W. T. J. Atkins opened the discussion, in which a dozen speakers took part, many of whom were more concerned with the difficulties of liaison with other organizations than with actual technicalities. Several mentioned the existence of the Joint Committee for the Co-ordination of the Cathodic Protection of Buried Structures, an organization with a frightening name but whose aim is to give mutual aid to those responsible for installations that are partly underground.

It was also pointed out that the mention of 20 mV, as a definite maximum permissible potential change when testing buried structures, was unfortunate, because while it appears to be approximately accurate it is only a temporary figure for use until the results of further research are known.

Mr. L. F. Scantlebury said that the Post Office had an average of 5000 faults a year on telephone cables, arising from corrosion. These faults cost £500000 to remedy. The Post Office had a large number of small protection schemes operating in country districts, and these were reducing the number of faults to 20% of their previous level.

Dr. J. M. Cowan gave a short account of a large scheme in Wales, where the Gas Board wished to protect 20 miles of steel gas main. Testing had been regarded as research and the costs had not mattered, but they had shown what a large amount of money could be spent on testing, and if the contemplated extension of this scheme for another 100 miles was carried out, the cost of testing on the same scale would be prohibitive.

Mr. Heselgrave briefly answered the points raised in this prolific and lively discussion.

The vote of thanks was proposed by the President, who said that he had found the proceedings of special interest, since he himself had once been concerned with the detection and tracing of leakage currents. Amid laughter, he confessed that with the progressive closing of the tramways the tracing of such currents had become markedly difficult, and he had therefore sought more congenial duties. Sir Gordon affirmed the importance of cathodic protection as a means of reducing the colossal annual expenditure on the replacement of corroded metalwork.

M. J. C.

MEASUREMENT AND CONTROL SECTION

Permittivity, Permeability and Bridges

The well-attended meeting on the 29th January 1957 opened briskly, with the Chairman, Mr. H. S. Petch, disillusioning those who had come along with the impression that they were going to listen to a discussion on d.c. amplifiers. This discussion, as announced in the *Journal*, had been postponed, and in its place four papers were read and discussed. These were *An Experimental Study of High-Permeability Nickel-Iron Alloys*, by C. E. Richards, E. V. Walker and A. C. Lynch, *A Method for the Precise Measurement of Permittivity of Sheet Specimens*, by A. C. Lynch, *A Bridge Network for the Precise Measurement of Direct Capacitance*, by A. C. Lynch, and *A Simple Transformer Bridge for the Measurement of Transistor Characteristics*, by W. F. Lovering and D. B. Britten. Short reviews of these papers will be found on pp. 277–279.

The discussion was long and forceful, and much of it centred around the paper by Richards, Walker and Lynch. The first line of their paper read, 'Because the properties of commercial alloys are inconsistent . . .'; they could not have chosen a better introduction to ensure a heated discussion. Neither side could claim a total victory in this discussion, but to the impartial observer the sensitivity of magnetic alloys to composition, heat treatment, contamination and mechanical handling left no doubt about the difficulty of obtaining consistency under commercial conditions. The fact that experiences on the effects of using ammonia as an annealing gas were contradictory showed how incomplete our knowledge is of the control of consistency. The authors felt that a greater control was possible with sintered alloys but acknowledged the economic disadvantages of the technique except in the production of very thin material.

The three other papers were discussed rather more serenely. Mr. Lynch successfully demonstrated the remarkable sensitivity of his bridge to small capacitance changes, using a loudspeaker as an audible indicator of unbalance. The audience also demonstrated their remarkable sensitivity to a 3 kc/s scream at full power, when the bridge accidentally became completely unbalanced. Mr. Lynch then proceeded to give an even more convincing demonstration of the freedom of his bridge from stray capacitance, first by reversing the leads to the specimen and secondly by connecting a 1000 pF capacitor from one side of the specimen to earth without any change in balance conditions being noticeable.

Mr. C. G. Garton suggested that the measuring circuit should henceforth be called the 'Lynch bridge'. In this way it would enjoy the dignity attached to other bridges named after their inventors, and he felt that this would ensure its use in the future. In passing, Mr. Garton deplored the modern fashion never to draw bridge circuits to look like bridge circuits, and he proceeded to show on the blackboard how simple the circuit could be made to look when drawn in the old-fashioned way.

At one stage in the discussion some of the authors were severely taken to task by Mr. J. K. Webb for using the C.G.S. instead of the M.K.S. system of units. He drew attention to the Council resolution on this matter, and suggested that recalcitrant authors should be made to toe the line; he

maintained that except for the very best of reasons the M.K.S. system should be made compulsory before publication was permitted. Mr. Lynch was quite unabashed, and defended himself on the grounds of using values which were familiar to the readers of his papers. When it came to Mr. Lovering's turn to reply to the discussion, his halo was clearly visible; he had written his paper in M.K.S. units.

It was never discovered how many of those attending the meeting had come under the misapprehension that they were going to hear something quite different. However, it was obvious from the atmosphere of the meeting that the alternative thrust upon them was quite welcome. R. S. M.

RADIO AND TELECOMMUNICATION SECTION

Acoustic difficulties led the Radio and Telecommunication Section to forsake the panelled walls of Savoy Place on the 20th February to hear a paper on, and the all-important demonstration of, *The 'Stereosonic' Recording and Reproducing System*, by H. A. M. Clark, G. F. Dutton and P. B. Vanderlyn, under the chairmanship of Dr. R. C. G. Williams.

The venue chosen was the new auditorium at the Northampton Polytechnic, St. John Street, E.C.1—a comparatively large hall in which to demonstrate an equipment specifically designed to give high-quality sound reproduction in rooms of domestic dimensions. Members' reactions to the change of environment were given a preliminary positive bias by the excellent refreshments that preceded the lecture.

Mr. Clark commenced by reminding us that the late Mr. A. D. Blumlein had, with his customary prescience, recognized that the quality of sound was determined as much by imponderable factors as by those characteristics susceptible to instrumental evaluation. A real orchestra has 'size', and Blumlein realized that this factor made a major contribution to listeners' enjoyment. On the broad foundations laid down by him, the modern 'stereosonic' system has been developed, advantage being taken of such later techniques as magnetic recording and directional capacitor microphones.

Mr. Clark admirably high-lighted the more important advantages of stereophonic sound reproduction before handing over the stage to Dr. Dutton, who drove home the points with a series of excellent demonstrations. It is quite safe to say that all present (including the expert members) were impressed by the quality obtained and by the demonstrations designed to show the directional characteristics of the human hearing system.

The discussion centred on the authors' explanation of the mechanism of stereophonic sound reproduction—perhaps an acknowledgment that at long last we had been given some examples of quality that everybody present considered to be 'hi-fi'. The theoretical background to the paper did not receive unqualified approval, and indeed it seems that as yet there is no theory that does not leave a rather large number of observations unexplained. Worse still, many of the theories are flatly contradicted by observed facts.

The discussion ranged over a wide field, from the mechanism of nerve transmission to the conductor's experience when conducting an orchestra. In an excellent speech, a model for all Institution discussions, Dr. E. C. Cherry claimed that steophonic sound reproduction was impossible and then went on to congratulate the authors on achieving it. Mankind is lucky that it does not have to wait for a full explanation of every phenomenon before putting it to good use.

The many points made during the discussion were dealt with by Mr. Vanderlyn, who had a difficult assignment in dealing with such a wide subject. J. M.

SUPPLY SECTION

Connected with Earth

'Unless otherwise allowed . . . a point on every such system shall be . . . connected with the general mass of the earth in such a manner as will at all times ensure an immediate and safe discharge of energy.'

The difficulties of complying with this regulation and related safety requirements where the soil has high resistivity are often before supply engineers. Less often discussed are the measures to be taken in large generating and transmission stations, where the problems, although of the same general character, are on a different scale. These were the topics of a paper *Earth Electrode Systems for Large Electric Stations*, which Mr. J. D. Humphries presented at a well-attended Supply Section meeting on the 27th March 1957. Mr. Humphries briefly summarized the paper and illustrated by a short film the process of surveying the earth voltage gradients round a major generating station, a study which he strongly recommended. This led later to expressions of envy at the equipment and facilities at his command. The film was unintentionally silent, but Mr. Humphries provided a very competent running commentary.

There was a lively discussion, conducted in an admirably spontaneous manner, but this dwelt more on ancillary details than on the paper's broad recommendations.

The opening speaker, Mr. L. Gosland, quoting highly respectable authority, welcomed the attention now paid to earthing as a basic element in station design, and reviewed some of the background considerations and the factual information available. Dr. G. F. Tagg gave an interesting account of the difficulties of interpreting resistivity measurements in stratified soils, whilst Mr. J. H. Gosden's very constructive contribution brought out the nobility of steel reinforcement in concrete, the baseness of cast iron in coke, and the way in which some of the author's doubts could be relieved by potential measurements of a kind and for a purpose quite different from those described in the paper. Mr. L. Czuros wanted more information on the standards the author had set himself, and on his assessment of earth fault currents.

Messrs. W. T. J. Atkins, P. W. Cave and W. S. Lovely, amicably sceptical, questioned the author's preoccupation with the earth connection. They held that the more dangerous voltages were those within stations; bonding, not earthing, was the more important requirement, and earth potential surveys were a luxury, not a necessity. The contrary opinion was also expressed. Mr. F. Tonge showed that the best and most recent Italian practice differed little from that proposed by the author, and Mr. W. H. Thompson described the very interesting and elaborate planning studies made to avoid the possibility of danger in a power station built upon a rock. Experience had shown precaution to be necessary.

Mr. Humphries replied broadly to the wide ranging discussion, sticking to his guns over the importance of his theme, and the Chairman, Mr. P. J. Ryle, as is his custom, preceded the vote of thanks with a very apt summary of the proceedings. The audience dispersed, satisfied that the paper recorded considerable advance in practice, but that the last word had not been said on the economy, efficiency and expediency of the prescriptions under review. L. G.

LONDON REPORT (*contd.*)

DISTRICT MEETING AT OXFORD

Impulse Testing

On the 13th March 1957, at the Oxford offices of the Southern Electricity Board, with Mr. D. Westwood in the chair, a paper on *Impulse Testing of Electrical Equipment for Supply Systems* was presented by Mr. D. Wadland, who traced briefly the development of impulse-testing technique from its inception to the present day. He explained its application to the testing of h.v. transformers. Chopped and full-wave impulses were demonstrated, and the significance of neutral-current oscillograms together with voltage oscillograms was discussed.

The demonstration equipment included a five-stage impulse generator developing 100 kV, which was applied to a transformer model, the waveforms being displayed on an oscillograph. Mr. Wadland was assisted most efficiently by his colleagues, Mr. P. M. Allen and Mr. R. F. James.

A vote of thanks was proposed by Mr. W. B. Tate. D. W.

DISTRICT MEETING AT READING

Mr. Halsey on the New Transatlantic Cable

Mr. R. J. Halsey, Assistant Engineer-in-Chief of the Post Office, gave a talk on the transatlantic telephone cable to a gathering of some eighty members and visitors at the George Hotel, Reading, on the 18th March 1957. In introducing the speaker, the Chairman, Mr. E. W. Weaver, referred to the joint effort of America, Britain and Canada regarding the planning and provision of this cable and said that Mr. Halsey, being in charge of the British contribution, was particularly well qualified to speak on the subject.

Mr. Halsey reviewed the research, which had extended over a number of years. He discussed problems which arose from the choice of route for the long sea section, and he recapitulated experiences obtained with submarine telegraph cables.

British experience on shallow-water cables and two-way repeaters primarily governed the decision that the United Kingdom should tackle the Newfoundland–Nova Scotia section, while American research on flexible one-way repeaters (capable of passage through a ship's cable-laying gear) governed the American responsibility for the twin cables between Scotland and Newfoundland.

With the aid of slides, Mr. Halsey ably demonstrated the salient features of manufacturing and laying. He explained the limiting factors affecting the number and spacing of repeaters, and described the permissible frequency range and power supplies. He outlined the special measures taken to ensure, as far as possible, a fault-free service for a minimum of 20 years, and referred to the dislocation of traffic and cost of repair if this expectation were not realized.

Mr. Halsey dealt fully with the many questions raised in the discussion, which covered the effects of the insertion of new lengths of cable as part of repair operations; the costs of provision and estimated revenue; trends in design of repeaters and cables and possible future projects of a similar kind. Gold-plated parts are used in the repeaters to avoid the phenomenon of spontaneous whisker growth, which may well cause failure.

A sincere vote of thanks proposed by Dr. T. E. Allibone was carried unanimously. E. W. W.

NEWS *from the Centres*

BATH

DISTRICT MEETING

R.A.F. Visitors at a Crowded Meeting

A highly successful District Meeting was held at Bath on the 21st March. Through the courtesy of the Principal, Mr. A. H. Yates, the meeting took place at Bath Technical College, and the goodly number of 140 attended. This number included visitors, of whom ten came from the R.A.F. station at Melksham. The occasion was an address by Mr. P. Godfrey on semi-conductors and transistors. He dealt with this difficult subject in a masterly way, which the discussion showed was much appreciated.

The number of visitors encouraged some missionary work on behalf of The Institution. This opportunity was taken, by pointing out to the audience the privileges and responsibilities attached to membership.

It was also a generous-hearted meeting in that the sum of £5 6s. 4½d. was collected on behalf of the Benevolent Fund. Can we assume that the halfpenny was someone's last?

For the success of the meeting much appreciation is due to the organizer, Mr. F. B. Alcock. D. J. T.

EDINBURGH

SCOTTISH CENTRE

Dinner at Edinburgh

Whereas the speeches at the Glasgow Dinner-Dance earlier this session struck a rather light-hearted note, some of those delivered at the Edinburgh Dinner on the 21st March, although very well seasoned with wit and humour, dealt with several important problems. Professor F. M. Bruce, Chairman of the Centre, presided, and in referring to the federated Scottish Centre he said that this had now passed out of the experimental stage and suggested that some of the experience gained might be used in the formation of a London and Home Counties Centre. The toast of The Institution was proposed by Mr. Ian D. McIntosh, Headmaster of George Watson's College. Mr. McIntosh had evidently made a careful study of Rollo Appleyard's *History of the Institution*, which he commended very highly, and from which he managed to extract a number of amusing anecdotes. In more serious vein, he discussed the attitude of the schools towards scientific training, and said that if the price of our new civilization was the destruction of the humanities, then the price was too high. He maintained that while much had been said about producing more scientists, not enough had been said about producing better ones, and that a scientific education is, in its own right, a good education. In replying to the toast, Sir Gordon Radley referred to the precarious economic position of the country and the recent crisis that had barely been overcome. Mr. W. K. Brasher was invited to say a few words about his recent visit to Russia, and he gave statistics of the very high number of technological trainees in that country. At this point, the clan Anderson took charge of the proceedings. Mr. R. B. Anderson, Chairman of the North Scotland Sub-Centre,

proposed the toast of the guests, to which the reply was given by Sir David Anderson, Director of the Royal College of Science and Technology, Glasgow, founded originally as the Anderson Institution.

Finally, Mr. F. G. Bennett, Chairman of the South-East Scotland Sub-Centre proposed the toast of the Chairman. Professor Bruce, in reply, very warmly thanked Mrs. J. H. P. de Villiers for acting as hostess throughout the session. Not only, he said, had she metaphorically held his hand on the social occasions but had done 'much more than this behind the scenes'—a remark that brought the proceedings to a hilarious conclusion.

Pocket Lecture

The only presentation of the Faraday Lecture in Scotland this session was in Edinburgh on the 28th March. Details of Dr. Allibone's outstanding lecture and its accompanying demonstrations have been given elsewhere. The vote of thanks to the lecturer in Edinburgh, proposed by Mr. W. B. Laing, Past-Chairman of the South-East Scotland Sub-Centre, was carried with prolonged acclamation by the very large audience present. In his final remarks Dr. Allibone explained the rather puzzling effectiveness of the public-address system, by describing how, with the co-operation of the B.B.C., he used an unobtrusive lapel microphone connected to a transmitter in his pocket feeding an aerial down his trouser leg, the signals being picked up by a receiver at the back of the stage and fed into the loudspeaker system. E. O. T.

PLYMOUTH

SOUTH-WESTERN SUB-CENTRE

Annual Dinner

Electrical engineers in the South-West of England met at Plymouth on the 18th January for the Annual Dinner of the South-Western Sub-Centre.

The Lord Mayor of Plymouth, Councillor Oats, in proposing the toast of The Institution, referred to the way Plymouth was developing technical education.

In his reply, Sir Gordon Radley, the President, reviewed the part played by engineers, saying that the world of to-day and the England of to-morrow would be largely fashioned by engineers. Already much had been done in the way of technical progress, and much more since The Institution had been formed than at any time in recorded history. The Institution, said Sir Gordon, existed to help engineers to do their work in this time of very rapid technical progress. It was a time when scientific research was increasing the possibilities at a very great rate.

Professor G. H. Rawcliffe, Chairman of the Western Centre, proposed the toast of the South-Western Sub-Centre, and the Chairman, Mr. W. Roy Rowe, who presided, made reference to the activities within the area and put forward a strong plea for the establishment of a full Centre of The Institution in the South-West. He also made reference to Mr. W. K. Brasher and to his son's recent achievement as a gold medallist in the Olympic Games.

The Earl of Mount Edgcumbe, a Past-President of The Institution, attended the dinner. W. R. R.

A group at the Annual Dinner of the South-Western Sub-Centre

From left to right: Mr. W. K. Brasher, the Earl of Mount Edgcumbe, Mr. W. R. Rowe, Councillor W. J. Oats, Sir Gordon Radley and Professor G. H. Rawcliffe.

By courtesy of the Western Morning News

LEEDS AND BRADFORD

NORTH MIDLAND CENTRE

At the fifth ordinary meeting at Leeds on the 5th February 1957, the chair was taken by the immediate Past-Chairman, Mr. F. Barrell, in the absence, through illness, of the Chairman, Mr. W. K. Fleming. A lecture on *The Crystal Palace Television Transmitting Station*, by F. C. McLean, A. N. Thomas, and R. A. Rowden, was given by Mr. Thomas before sixty members and guests. The speaker said that after twenty years' satisfactory operation, it had been decided to replace the station at Alexandra Palace, and the three considerations which were of paramount importance were higher power, highest reliability, and a location on the south side of the Thames. The site at Crystal Palace admirably fulfilled these requirements, and approval was obtained under the Stockholm Plan for a 500 kW transmitter, which started working with an effective radiated power of 200 kW in March 1956. He explained the increased aerial gain which had been obtained by utilizing the aerial tier system, and described the many interesting facets of the building and the equipment. A vigorous discussion was opened by Dr. L. E. Ryall, who commented on the amusing verbal embroidery with which Mr. Thomas had enhanced the text; he also remarked on the lines which the Post Office made available for outside broadcasts. Twelve other members contributed to the discussion, which ranged over light current, heavy current, policy, availability of supply and consumer interest. Our thanks to the speaker were expressed by Mr. A. J. Coveney for a most interesting evening.

UTILIZATION GROUP

We are always pleased to have a return visit of a personality whom we admire, and in these terms our Chairman, Mr. R. Spence, welcomed Mr. E. R. Laithwaite at the fourth Group meeting on the 19th February. Mr. Laithwaite read two papers of which he is joint author—*Brushless Variable-Speed Induction Motors*, with Professor F. C. Williams and Mr. L. S. Piggott, and *A Self-Oscillating Induction Motor for Shuttle Propulsion*, with Mr. P. J. Lawrenson. The speaker said that these two subjects, which were apparently divorced, had in fact a great deal in common, and he reported that the first

motor had now passed the museum stage and had become a much more promising piece of equipment. He described it as a method of changing the pole pitch continuously, but the motor can also be used with fixed stators. It may be fed from phase-shifters, and it is, of course, a spherical machine.

Referring to the second motor, Mr. Laithwaite gave a most convincing demonstration of the practicability of this type of self-oscillating motor and revealed something of the tremendous changes in loom construction which might result from its development.

The discussion, which was opened by Mr. A. J. Francis and supported by several other speakers, must have shown Mr. Laithwaite the very great interest of members of the Group, even if some Yorkshire reserve was shown towards the revolutionary suggestions on loom construction. Our Chairman thanked the speaker on behalf of our members for the papers, and for his racy and humorous presentation.

GRADUATE AND STUDENT SECTION

The recent activities have been both interesting and successful. Members have had the pleasure of a lecture on *Management from Top to Bottom*, by Mr. W. H. Dunkley, who is always a staunch supporter of Student affairs. The Centre Chairman, Mr. W. K. Fleming, gave his address. Other items on the programme for the quarter were two successful works visits, a joint meeting at Bradford with the Graduate and Student Section of the Sheffield Sub-Centre to hear a paper on *The Automatic Factory*, by Mr. C. F. Stewart, and finally the Annual Dance, which was greatly enjoyed by the (unfortunately) small number of members present. J. L.

SOUTHAMPTON AND WEYMOUTH

SOUTHERN CENTRE

It is very pleasant to record a continuing series of successful meetings at Weymouth under the chairmanship of Dr. J. H. Mole. The lectures given by Mr. T. H. Kinman on germanium and silicon rectifiers and by Mr. R. Postlethwaite on computers attracted good audiences and resulted in spirited discussions at the South Dorset Technical College. Both meetings were favourably reported in the local Press.

Dr. T. E. Allibone proved a tremendous 'draw' when he gave this year's Faraday Lecture at the Guildhall, Southampton. The lecture was given to 1 800, although there is seating for only 1 750. Many applications for tickets, perforce, were refused, and all this in spite of petrol-rationing.

In this sea-conscious area, a topical question is the possibility of the application of nuclear power to marine propulsion, in particular for naval purposes. It was particularly gratifying to the Committee, therefore, to have as guests Rear-Admiral G. O. Naish, Engineering Adviser to the Commander-in-Chief, Portsmouth, and Vice-Admiral J. S. C. Salter. Dr. W. Taylor, Head of the Portsmouth College of Technology, proposed the vote of thanks.

The Mayoress of Southampton, Alderman Mrs. K. E. Cawte, acted as Chairman to introduce the lecturer and other speakers, and she showed the greatest appreciation of the subject of the lecture and the possibilities of improved prosperity resulting from it. So much so, that it required tactful reminders at a late hour that many of the Committee had to return to distant homes before the Mayoress could be induced to terminate her private cross-examination of Dr. Allibone and allow the party to disperse. E. A. L.

NEWS *from Abroad*

DUBLIN

IRISH BRANCH

During the present session, Ordinary meetings and Committee meetings were well attended, as also were those of the Graduate and Student Section, now formally and, we feel, firmly established. The Senior Committee has been particularly active, and its nominees have served as representatives of The Institution on:

The Irish National Committee on Illumination,

The Joint Advisory Committee (i.e. the Irish Branch of The Institution of Electrical Engineers, The Institution of Civil Engineers of Ireland, and The Engineers' Association), and

The Advisory Committee to the City of Dublin Vocational Education Committee.

A sub-committee also co-operates with the Institute of Science and Technology, Dublin, regarding suitable courses and equipment for electrical engineering students, particularly in connection with the preparation of such students for The Institution's Examination.

Our Annual Dance, held on the 11th February 1957, was well attended but not overcrowded, and from all reports received subsequently it was one of the most enjoyable of our social functions held during the past few years. On this occasion we were privileged to have with us as our special guest the Rt. Hon. the Lord Mayor of Dublin, Councillor Robert Briscoe. The Chairman, Mr. P. H. Greer, delivered a short address of welcome to the guests, to which the Lord Mayor replied with a very witty speech that put everyone in good humour for the rest of the evening.

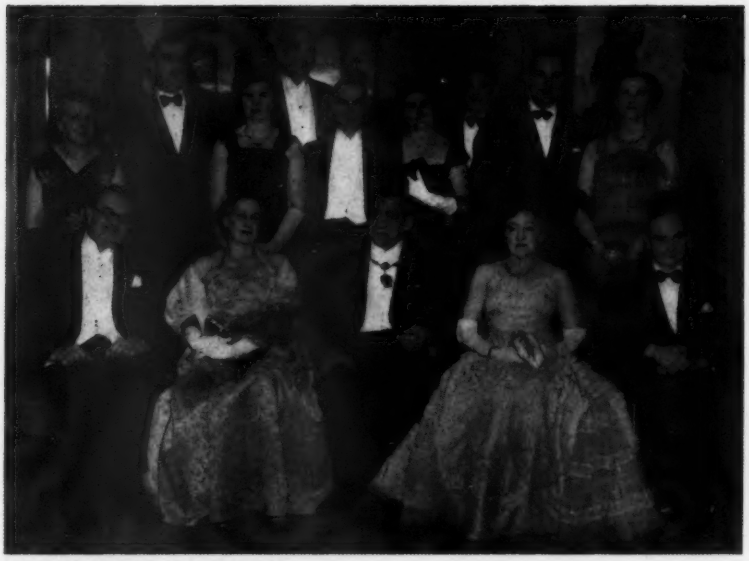
A notable event in Dublin early this year was the 'first ever' Electricity and Productivity Conference and Exhibition, held at the Royal Dublin Society's Exhibition Hall from the 18th to 22nd February. It was sponsored by the Electricity Supply Board, from whom invitations to attend were issued to managers, engineers, trade union officials and others vitally interested in productivity, and about 8 000 attended during the five days of the conference. It was not primarily a trade show, its main purpose being to educate visitors on how to increase productivity by the adoption of modern, and particularly electrically operated, machines. Over fifty manufacturers of modern production equipment exhibited their machines and apparatus at stands in the Exhibition Hall, and fully experienced staff were available to give expert advice on all matters concerning increased productivity. Pertinent films were shown, and lectures delivered, each day.

The exhibition was opened by the Chairman of the Electricity Supply Board, Mr. R. F. Browne, and at its close a large number of firms that took part in it expressed their pleasure at the efficiency and excellent organization that contributed to the—in their opinion—outstanding success of the exhibition. It was, they said, the best of its kind in which they had ever taken part, not excluding some of the very much more ambitious exhibitions held elsewhere, and orders for equipment were secured beyond their most optimistic expectations. It is to be hoped that similar exhibitions will be held at regular intervals in the future.

An earlier report in the *Journal* mentioned a new generating station in course of erection by the Electricity Supply Board at one of the large bogs near Ferbane, Co. Offaly, the boilers being designed to utilize milled-peat fuel. The building has now been practically completed, and the large boiler of one of the three 20 MW sets is at present undergoing tests. The set was synchronized with, and connected to, the system on the 11th February, and the load was 22 MW. Except for some minor troubles in the fuel-handling plant, the tests made so far have proved very satisfactory. Since this is the first generating station in Europe, outside Russia, to use milled-peat fuel, the boilers and the fuel-handling plant had to be very carefully designed.

It is expected that all three 20 MW sets will be in operation in less than a year.

J. D. F.



The Irish Branch Annual Dance

Seated, from left to right: Mr. D. S. Parry, Mrs. P. H. Greer, Councillor R. Briscoe (Lord Mayor of Dublin), Mrs. D. S. Parry and Mr. P. H. Greer.

Standing, from left to right: Mrs. J. D. Ferguson, Mr. A. J. Litton, Mrs. T. S. Wylie, Mr. J. D. Ferguson, Mr. L. Collins, Mrs. L. Collins, Mr. C. V. O'Donnell, Mr. T. S. Wylie and Mrs. A. J. Litton.

ADELAIDE

SOUTH AUSTRALIA OVERSEA COMMITTEE

A Stimulating Session

At the June meeting, Mr. G. F. R. S. Hore described and demonstrated some *Small Electric Motors for Use in Servo-Mechanisms*. Perhaps his most impressive exhibit was a small hysteresis motor, which was shown to accelerate from rest and synchronize itself with a 400 c/s supply within one-tenth of a second—an angular acceleration of approximately 25 000 radians/sec^2!

Mr. R. Lawrance and Mr. R. F. Treharne dealt with the theory and applications of transistors at the July and August meetings, both of which were very well attended.

In September, Mr. R. M. A. Olesnicki, of the Electricity Trust of South Australia, was the speaker, and his subject *Some Remarks on the Stability of Power Systems* included a survey of studies made on the Port-Augusta–Adelaide transmission system. The problem of transmitting power from a remote station situated near a source of fuel to a metropolitan load centre is not uncommon. In this case the distance involved is about 190 miles. Port Augusta is at the northern extremity of Spencer Gulf and is the nearest coastal site to the inland brown-coal field at Leigh Creek, which is surrounded by the dry countryside of South Australia's 'mid-north'. Lake Torrens, which at first sight would appear to hold an adequate supply of cooling water, is merely a vast area of dry salt pans in all except extraordinary seasons.

Interest in television throughout Australia has been stimulated by the advent of regular transmissions from national and commercial stations in Melbourne and Sydney. Mr. Emlyn Jones, a Fellow of the Television Society, discussed *Some Aspects of Television-Receiver Design* at the October meeting, and in November a joint meeting with The Institute of Radio Engineers (Australia) was held at the works of Philips Electrical Industries, when Mr. G. Mak led a discussion evening and demonstrated some commercial receivers.

The Annual General Meeting was held on the 29th November and took the form of a buffet dinner and an informal social. Mr. J. W. Harrod gave an entertaining account of his recent travels in Europe and America, illustrating his remarks with colour slides of subjects of technical as well as of general interest.

The Committee, in its Annual Report, noted a 25% increase in the total number of members resident in South Australia, the number in mid-November being 146.

At its first meeting in 1957 the Committee elected Mr. A. J. H. Oxford its Chairman for 1957. Mr. Oxford, who is a Superintendent at the Weapons Research Establishment, Department of Supply, has been in Australia since 1950. He was actively engaged on signal and radar research in the United Kingdom throughout the last war. J. W. C.

KUWAIT

IRAQ AND PERSIAN GULF JOINT OVERSEA GROUP

A Convergence of Engineers

Thursday the 28th February was a day to be remembered in Kuwait. From Baghdad, Basra, Masjid-i-Sulaiman and even Teheran, contingents of engineers arrived by plane for that afternoon's meeting of the Iraq and Persian Gulf Joint Oversea Group. London and Switzerland were also represented on the attendance list. The reason for this eagerness was the reading of a paper by W. Downie and S. C. Hardy, who are the two senior engineers responsible to the Iraqi Ministry of Development for their programme of road and bridge building. The paper was a masterly analysis, both structural and economic, of the work which Mr. Downie and Mr. Hardy have directed.

On the Friday our members inspected the recently opened Display Centre of the Kuwait Oil Co. at Ahmadi, with its

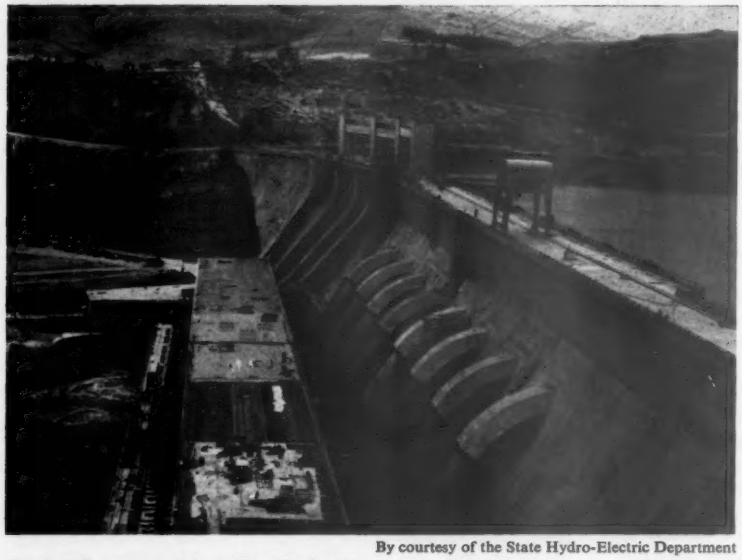
pictorial and graphical presentation of the work of an oilfield, and we were shown a film describing the formation and winning of oil. Three launches then took us to inspect the tanker-loading terminal at Mina-al-Ahmadi. Lunch at the company's guest house concluded a successful week-end.

We were again indebted to the Kuwait Oil Co. for the facilities to hold the meeting and for tea. On this occasion we were indebted to them also for an excellent buffet supper on the Thursday. J. A. C. K.

WELLINGTON

NEW ZEALAND OVERSEA COMMITTEE

Although the wide distribution of members in New Zealand makes any organized Institution function a regrettably rare occasion, members do play their part in the activities of the New Zealand Institution of Engineers. Two Associate Members, Mr. H. C. Hitchcock and Dr. S. Rothmann, recently presented a paper on the plant and equipment installed in the State Hydro-Electric Department's newest South Island power station at Roxburgh, on the Clutha River.



By courtesy of the State Hydro-Electric Department

Roxburgh power station, New Zealand

The paper described briefly the main features of the scheme —the 1 200 ft-wide gravity-section concrete dam giving a head of 150 ft, and having a spillway with three 130-ton gates capable of discharging 150 000 cusec of flood water. It sketched construction progress from its beginning in 1949 until the successful diversion of the river in the winter of 1954, when increasingly rapid progress was made possible. The work culminated in spectacular efforts to relieve a severe power shortage, with the commissioning of the first unit on the 23rd July 1956. It is to the credit of the erection staff and the manufacturers that within eight hours of the water being available the first unit was delivering 80% of its rated output, the maximum that the interim water level would allow.

Mention was made of the control works on Lakes Hawea and Wakatipu, which will store the spring flood and summer run-off to provide a controlled mean flow of 15 000 cusec which, on the basis of 50% load factor, allows the station a total rating of 320 MW. Transport limitations required this to be in the form of eight 40 MW 136·36 r.p.m. 11 kV units, of which four make up the initial installation.

Of the eight 44·4 MVA transformer banks, five will be rated at 11/220 kV for the 243-mile transmission to Christchurch, while the other three will be rated at 11/110 kV for the supply of power over the lesser distances to Dunedin and Gore. A 50 MVA 220/110/11 kV interconnecting auto-transformer is provided.

All high-voltage circuit-breakers are of an air-blast type and those on the 220 kV transmission lines are used for high-speed reclosing of 3-phase and/or single-phase circuits, according to the setting of the relay equipment. All transmission lines have carrier-current communication equipment, which on the 220 kV line is used also for intertripping of circuit-breakers. An 'oscilloperturbograph' is provided at each end of the 220 kV line to record relay operation.

As the completed station will be for some years about 50% of the generating capacity in the whole of the South Island, the essential auxiliaries are supplied from duplicate house-service hydro-sets, each rated at 500 kW 400/230 volts, with an alternative supply from a 750 kVA service transformer fed from the 11 kV tertiary winding on the auto-transformer bank. For control purposes, circuit-breaker closing and the small amount of emergency lighting, a direct voltage of 110 volts is supplied from nineteen motor-car-type 6-volt batteries.

Feeder and sub-circuit protection throughout the 400/230-volt power and lighting system is by means of high-rupturing-capacity fuses, because miniature circuit-breakers (used on earlier stations) are not available with sufficiently high interruption capacity.

In the discussion, a feature unusual for New Zealand was the participation of the manufacturer's design engineer, Dr. J. H. Walker, who also brought fraternal greetings from the Rugby Sub-Centre of The Institution

The official opening on the 3rd November by the Hon. W. S. Goosman, Minister of Works and of Transport, marked with fitting ceremony the notable stage now reached in South Island power supply, and the issue in the near future of the specifications for the remaining four generating units promises an abundance of power until 1965 at least. H. C. H.

OVERSEA ATTENDANCE REGISTER

During the period 1st March to 31st March 1957 the following members called at the Institution Building and signed the Attendance Register of Oversea Members:

AINSWORTH, W. A. (Butterworth, Malaya)
BRADY, L. (Aden)
BROADBENT, D., B.SC. (Melbourne)
CORNISH, H. E., M.C., B.SC.(ENG.) (Sarawak)
FITTON, T. W. E. (Accra)
GUNASEKARA, W. C. S. DE Z. (Colombo)
JAY, R. A. (Kumasi, Ghana)
KIPNIS, L. A., DIPL.ING., B.SC. (Israel)
PRESCOTT, C. (Brockville, Ontario)
RAIMONDO, A. (Malta, G.C.)
WILLOUGHBY, G. P., O.B.E., M.SC.TECH. (Kenya)
WORKMAN, A. H. (Iraq)